THE ORIGIN AND FATE OF AIRBORNE POLLUTANTS WITHIN THE SAN JOAQUIN VALLEY

VOLUME 5 - FALL FIELD STUDY

by

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ABSTRACT

An extensive observational program, lasting from November 1978 until October 1979, was carried out to investigate the origin and transport of pollutants in the San Joaquin Valley. Volume 3 describes the results of the November 15, 1978 - December 10, 1978 intensive field study, along with two additional tracer experiments conducted during relatively stagnant conditions in February 1979 and in March 1979. Volume 4 describes the summer (July 1979) program. The present volume (Volume 5) describes the fall (September 1979) program. A description of the field procedures is contained in Volume 2. Volume 1 contains an executive summary.

Participants in this study were Meteorology Research, Inc., California Institute of Technology, Rockwell International (EMSC) and Environmental Research and Technology (ERT).

Six tracer releases provided the core of the September 1979 field program. These releases were supported by supplementary meteorological observations and airborne air quality sampling. Three Rockwell International vans, located at Reedley, Arvin, and Lost Hills, operated continuously to provide additional air quality data. Filter samples obtained at each of the vans were analyzed by ERT to investigate the particulate chemistry in the area.

The September 1979 field program was characterized by temperatures at the 850 mb level which were warmer than the 5-year average suggesting conditions more conducive than average for pollutant build-up.

Average wind flows at Stockton and at Los Banos were directed into the valley at all hours of the day.

Average winds at Fresno, Visalia, and Bakersfield reflected the development and northward spread of the "Fresno" eddy, which tends to rotate counterclockwise and extends to an average depth of about 1200 m. Some of the northwesterly flow approaching the eddy is carried aloft, to an altitude where the air can pass out of the valley to the southeast. The eddy developed during 17 of the 22 nights of the field program.

The nocturnal wind jet formed on most of the nights during the September field program. Peak wind speeds sometimes over 15 mps occurred between 300-400 meters above ground level, between 2100 and 2300 PDT.

Mixing layer heights during mid-afternoon ranged from 600 to 1200 meters above ground level during the tracer release days.

Maximum ozone concentrations observed during the tracer release days ranged from 0.12 to 0.17 ppm. Although the ozone concentrations were relatively uniform throughout the valley, Arvin frequently reported the highest values. During the days of tracer release, the maximum concentrations of carbon monoxide and NO_x ranged from 1 to 6 ppm and 0.17 to 0.39 ppm, respectively. Both the CO and NO_x concentrations reflected strong urban sources and were closely related to peak traffic periods.

Tracer released from Oildale during the late morning of 9/5/79 was initially transported towards Shafter by drainage winds from the southeast. During the early afternoon, the winds reversed and mixed the tracer over a wide area with measurable impacts being noted in Mettler and Lake Isabella as well as regions east and southeast of the release site. About 85 percent of the tracer was transported into the Mojave Desert by the evening following the release. The time of arrival of the tracer in the Mojave Desert indicted that the southern part of the San Joaquin Valley is the source of aerosols that typically reduce visibility from 100 miles or more during the day to less than 50 miles at night at the China Lake Naval Weapons Center.

Tracer released during the early morning at Oildale on 9/8/79 was transported in a manner very similar to the previous test. The earlier release apparently contributed only to spreading the tracer more uniformly throughout the zones of impact.

Tracer released during the late morning at Fellows on 9/11/79 was transported upslope by easterly winds. The convergence of an easterly flow on the western side of the valley and westerly flow from the coast apparently transported the tracer aloft; consequently the ground level concentrations of the tracer within the San Joaquin Valley were quite low.

Tracer released during the early morning from Fellows on 9/14/79 was transported by the early morning southwesterly drainage winds. Typical nighttime drainage conditions lead to the development of a flow convergence line near the center of the San Joaquin Valley. During this experiment, however, the tracer was efficiently transported past the predicted convergence zone and detected at Bakersfield and Oildale within about 10 hours after the start of the release. After the onset of the daytime upslope flow pattern, the tracer was transported into the Tehachapi Mountains and presumably into the Mojave Desert.

Tracer released during the hours around midnight from Oildale on 9/16/79 and 9/17/79, was initially transported by the drainage winds towards the center of the valley and as far north as Delano and Richgrove. During the afternoon, the upslope flow transported the tracer into the southern part of the Sierra National Forest, 25-50 miles north of Bakersfield.

Most of the tracer released during late morning and early afternoon from Manteca on 9/21/79, was transported slowly along the eastern side of the valley. However, some of the tracer was apparently transported by strong winds from the north which existed in the western side of the valley, and gave rise to a distinct tracer plume at Bakersfield during mid-day on the day following the release.

In summary, the meteorology of the San Joaquin Valley during September 1979 was very similar to that observed during July 1979. The transport of airborne material is generally southward in the San Joaquin Valley, by surface layer winds and by the nocturnal jet.

The nighttime downslope flow leads to the development of a flow convergence in the center of the valley. The convergence zone does not, however, pose more than a temporary barrier to cross-valley mixing in the southern half of the valley.

During the summer and early fall the most effective ventilating mechanism of the San Joaquin Valley is the daytime upslope flow over its mountainous southeastern boundary. The daytime upslope flow in the southern end of the valley leads to a significant impact of valley pollutants upon the western Mojave Desert. Even with the upslope flow ventilation mechanism, the potential exists for significant carryover of a pollutant into days subsequent to its release.

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1. Introduction

September is a transition month from summer to fall in the San Joaquin Valley. Surface temperatures begin to decrease from the intense heating days of summer. Stability tends to increase with corresponding decreases in mixing height toward the very stable, low mixing height conditions characteristic of late fall and winter. Cold air troughs pass through the area aloft producing marked changes temporarily in stability and mixing heights before the stability returns.

The problems of concern in the valley during September are similar to those occurring in the summer months. These problems include transport patterns within the valley, ventilation mechanisms for removal of pollutants from the valley and a characterization of the air quality and particulate chemistry.

The September field program included six tracer releases as listed below. The releases were concentrated in the southern part of the valley where the greatest potential for air quality problems was expected. Each release was supported by pibal soundings and aircraft measurements. A network of five additional pibal observations was provided by the CARB. These were located at Stockton, Los Banos, Fresno, Visalia and Bakersfield for the duration of the field program. The two pibal sounding locations supported as a part of the field study were moved on a test-by-test basis to provide the best possible wind coverage.

Three Rockwell International air quality vans were located at Reedley, Arvin and Lost Hills for the period of the field study. Environmental Research and Technology (ERT) provided filter samplers which were operated by Rockwell personnel at each van. Analysis and interpretation of the filter samples were carried out by ERT. The Atmospheric Testing Branch of the CARB at El Monte obtained hydrocarbon samples several times daily at Arvin and Lost Hills. The samples were subseqently analyzed by CARB for C_2 through C_{10}.

The following tracer releases were carried out during September 1979:

Release Location	Date (September 1979)	Release Time (PDT)
Oildale	5	0700-1200
Oildale	8	0200-0700
Fellows	11	0700-1200
Fellows	14	0147-0647
Oildale	16-17	2200-0337
Manteca	21	0900-1200

The present volume (Volume 5) discusses the details of the September field program including all pertinent tracer and aircraft sampling data (Appendix to Volume 5). Surface and pibal wind data have been furnished to CARB on magnetic tape. Separate reports (Volumes 6 and 7) give the details of the Rockwell International and ERT work, respectively. Portions of these reports have been used in the present volume where appropriate.

Volumes 3, 4 and 5 of the report series cover the details of the three field programs. Volume 2 contains an extended summary of the entire program and a discussion of a number of special analysis topics which resulted from the field measurement program. Volume 1 is an Executive Summary of the program.

2. Overview of the Meteorology and Air Quality

2.1 Introduction

The following sections describe the general conditions which occurred during the September 1979 intensive field period. The overall meteorological conditions are summarized and compared to climatological records to determine the representativeness of the test period. Descriptions of the air quality and particulate concentrations for the intensive period are summarized from the more extensive reports by Rockwell International and ERT which appear as Volumes 6 and 7 of this report series.

2.2 Meteorology

850 mb Temperatures

Temperatures at 850 mb provide an indication of vertical stability and the relative degree of existing air pollution potential. Warm temperatures aloft tend to increase the stability and contribute to trapping of the pollutants in the low layers.

Figure 2.2.1 shows the distribution of daily 850 mb temperatures at Vandenberg AFB and Oakland for the month of September 1979. Five-year average temperatures for the month are also shown.

The figure shows an extended period of warm temperatures from the 5th to the 23rd of the month. All tracer tests were conducted during this period. Tests 3, 4 and 5 were all carried out with 850 mb temperatures 6-8°C above normal. The period from the 9th through the 17th of the month (including the three tests) is representative of the most stable conditions to be expected in September.

Surface Pressure Gradients

Surface pressure gradients between the coast and the inland areas east of the Sierras serve to drive the low-level wind system in the San Joaquin Valley during September. Average gradients between San Francisco Airport and Las Vegas during September 1979 are shown in Table 2.2.1 for various times of day. Variations around these average numbers occur as the result of occasional weak, cold air trough passages through the area. Values shown in the table indicate peak gradients in the late afternoon and evening in response to the surface heating east of the mountains. Average pressure gradients are significantly lower than observed in July.

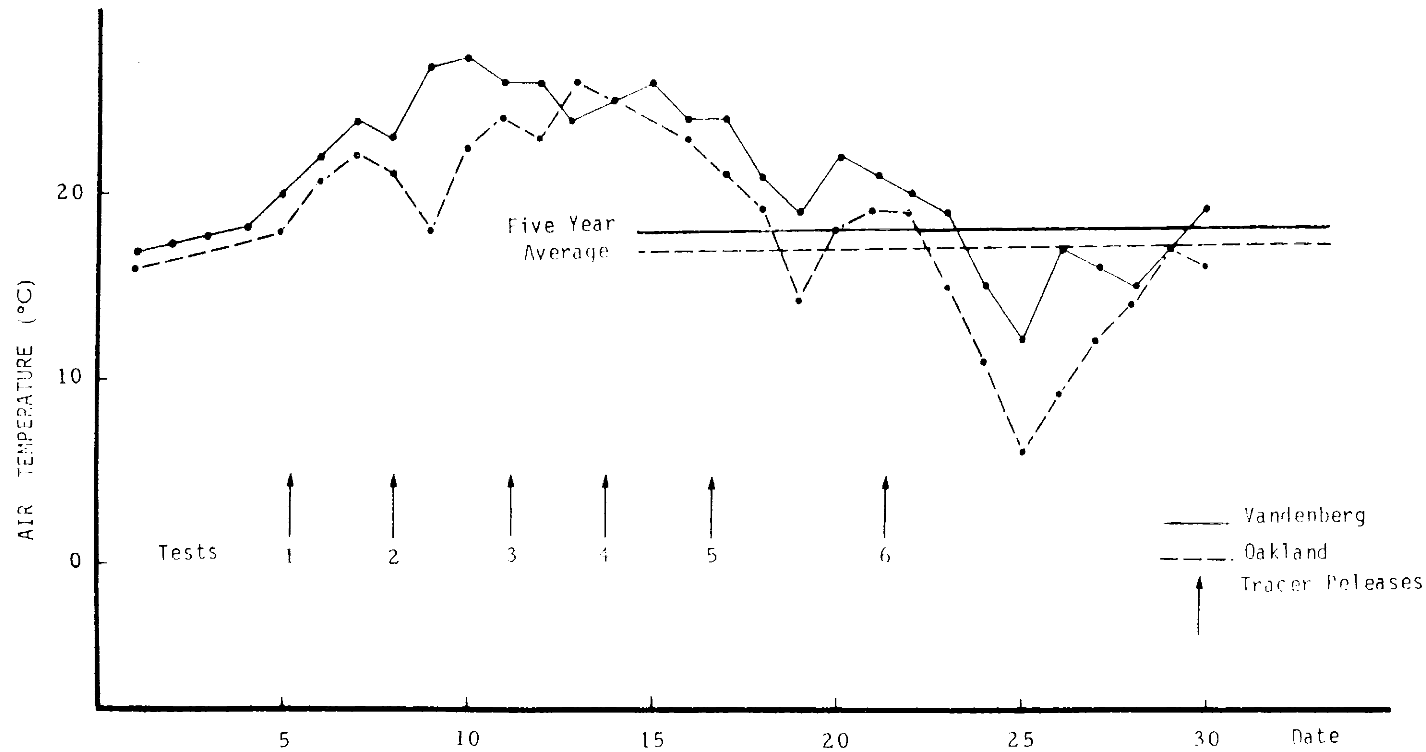

Figure 2.2.1 850 mb Temperatures - September 1979

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Table 2.2.1

AVERAGE SURFACE PRESSURE GRADIENTS (SEPTEMBER 1979)
SAN FRANCISCO TO LAS VEGAS

Time (PST)	Pressure Difference (mbs)
00	3.7
03	3.0
06	1.8
09	1.4
12	2.5
15	3.7
18	3.4
21	3.5

Day-to-day variations in the surface pressure gradient (SFO-LAS) for 16 PDT are shown in Figure 2.2.2 together with the six-year average gradient for September. Four of the tracer tests (3, 4, 5 and 6) were conducted during below average gradient conditions.

Figure 2.2.2 also shows the wind component along the valley axis at 600 m (agl) for Stockton and Los Banos. Positive component values refer to flow from Stockton to Bakersfield. There is a considerable similarity between the wind components and the variations in pressure gradients although the correlation is not perfect.

Figure 2.2.3 shows the 600 m wind component at Bakersfield in relation to the SFO-LAS pressure gradient. Good correspondence between the two curves is indicated in the first half of the month but the relationship deteriorates in the latter part. It is to be noted that the correlation between wind components at Bakersfield and the northern end of the valley is not particularly good during September 1979. While the principal driving force for the low-level winds in the valley is the surface pressure gradient, local wind variations within the valley are evident.

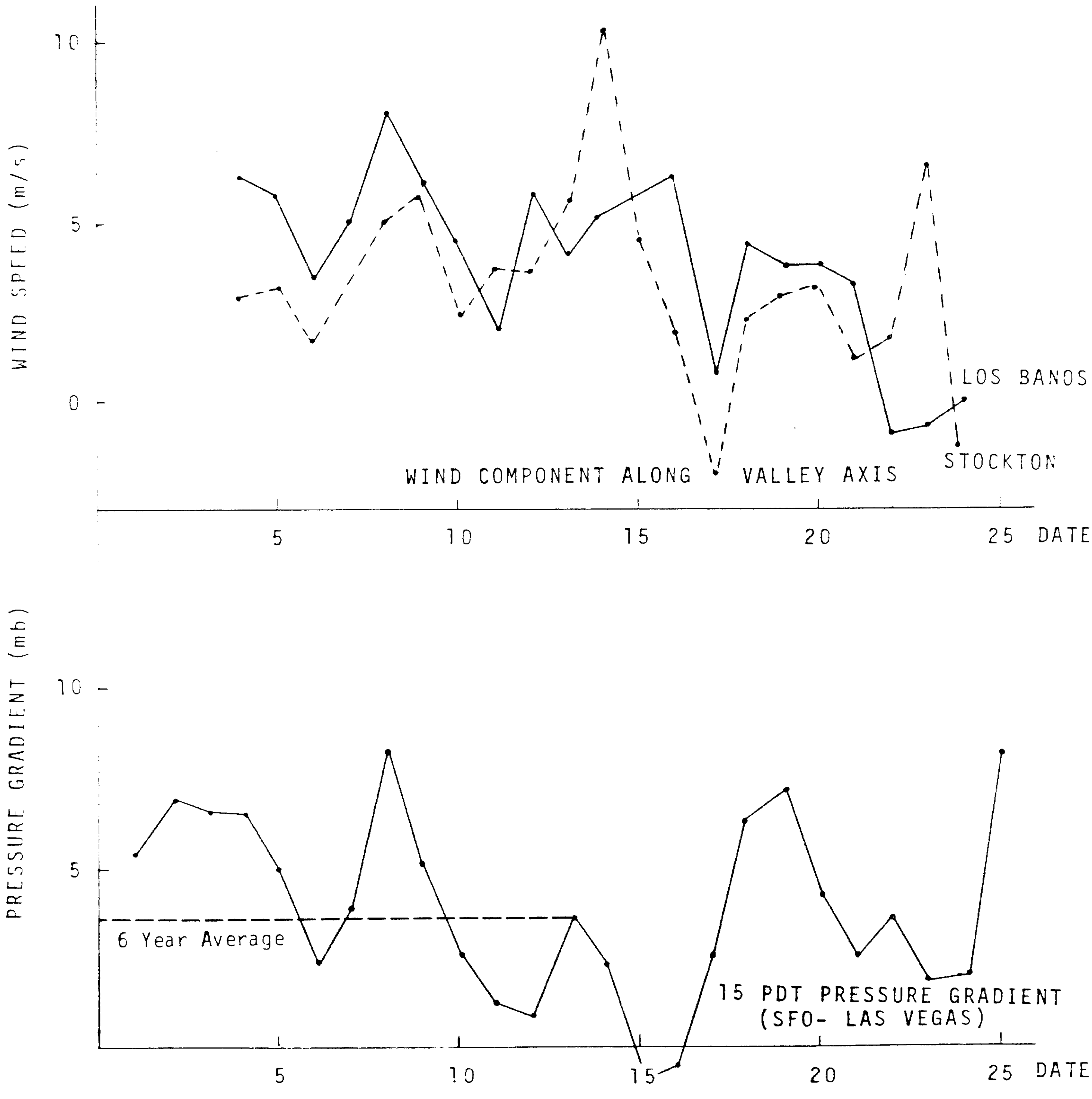

Figure 2.2.2 Comparison of Wind Component (600 m) and Pressure Gradient
September 1979

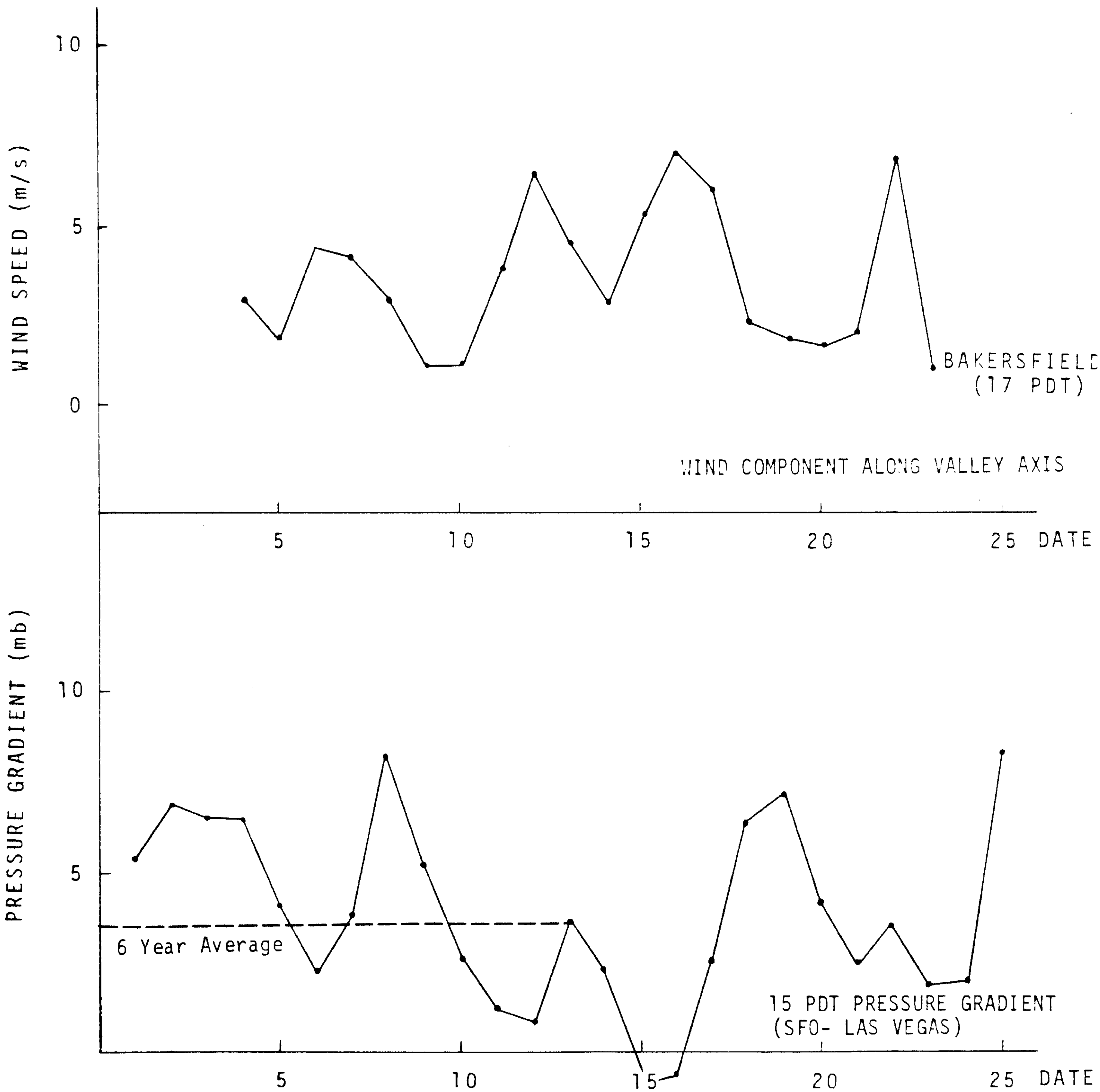

Figure 2.2.3 Comparison of Wind Component (600 m) and Pressure Gradient September 1979 81/056

Valley Wind Characteristics

Pibal wind observations were made at five locations in the valley on 21 days during September 1979. Routine measurements were made at 05, 09, 13, 17 and 21 PDT on these days with supplementary observations at other hours during tracer days.

Resultant winds for the 21 day period are shown in Table 2.2.2 for each location and each of the routine reporting times. The following features are apparent in the table:

- Northwesterly winds prevail at Stockton and Los Banos for all hours.
- Fresno (09 and 13 PDT) and Visalia (05, 09 and 13 PDT) show the effects of the Fresno Eddy developing in the south and spreading northward.
- Bakersfield winds show decreased velocities beginning at 21 PDT and continuing until 13 PDT as a result of the low-level blocking of air which is unable to pass over the terrain at the south end of the valley.
- Peak wins occur at 21 PDT at all stations except Bakersfield.

Table 2.2.2

1000-FOOT RESULTANT WINDS (m/s)
SEPTEMBER 1979

Location PDT	05	09	13	17	21
Stockton	301°/3.9	309°/3.0	303°/3.2	301°/5.6	288°/5.7
Los Banos	304 /3.9	321 /2.9	340 /2.6	334 /4.3	326 /5.6
Fresno	340 /3.5	122 /2.7	220 /1.2	299 /2.7	318 /8.9
Visalia	155 /2.6	166 /3.7	255 /1.5	316 /2.6	320 /5.1
Bakersfield	027 /0.1	135 /0.5	294 /1.8	294 /3.6	309 /2.1

Wind velocities at the five pibal locations were resolved into components along the valley axis with a positive value representing flow from Stockton to Bakersfield. Average components during September 1979 are shown in Table 2.2.3. Also given are average surface wind components at Stockton for the month of September 1975.

Table 2.2.3

WIND COMPONENTS* ALONG VALLEY AXIS (SEPTEMBER)

a. Surface Winds (m/s) - 1975

Location	Time (PST) 03	09	15	21
Stockton	1.3	2.6	4.2	3.1

b. 1000-foot Winds (m/s) - 1979

Location	Time (PDT) 05	09	13	17	21
Stockton	3.4	2.8	2.8	4.9	4.2
Los Banos	2.8	2.8	2.5	4.2	5.5
Fresno	3.4	-2.2	-0.6	2.5	8.7
Visalia	-2.6	-3.6	0.4	2.5	5.0
Bakersfield	0.1	-0.5	1.5	2.9	2.0

* Negative components refer to southeasterly winds

The following characteristics are indicated in the table:

- Wind components at Stockton and Los Banos are directed toward Bakersfield for all hours of the day.
- Peak flow into the valley occurs between 17 and 21 PDT.
- Fresno, Visalia and Bakersfield all show the effects of the Fresno Eddy during the early morning hours.
- The 17 PDT wind components show reasonable continuity throughout the length of the valley. For the remaining hours, substantial areas of convergence or divergence are indicated.

Average wind component profiles along the axis of the valley have been calculated for each of the five pibal locations and for five periods during the day. Averages were taken over the 21 day period of available data from September 1979. These profiles are shown in Figures 2.2.4 to 2.2.8.

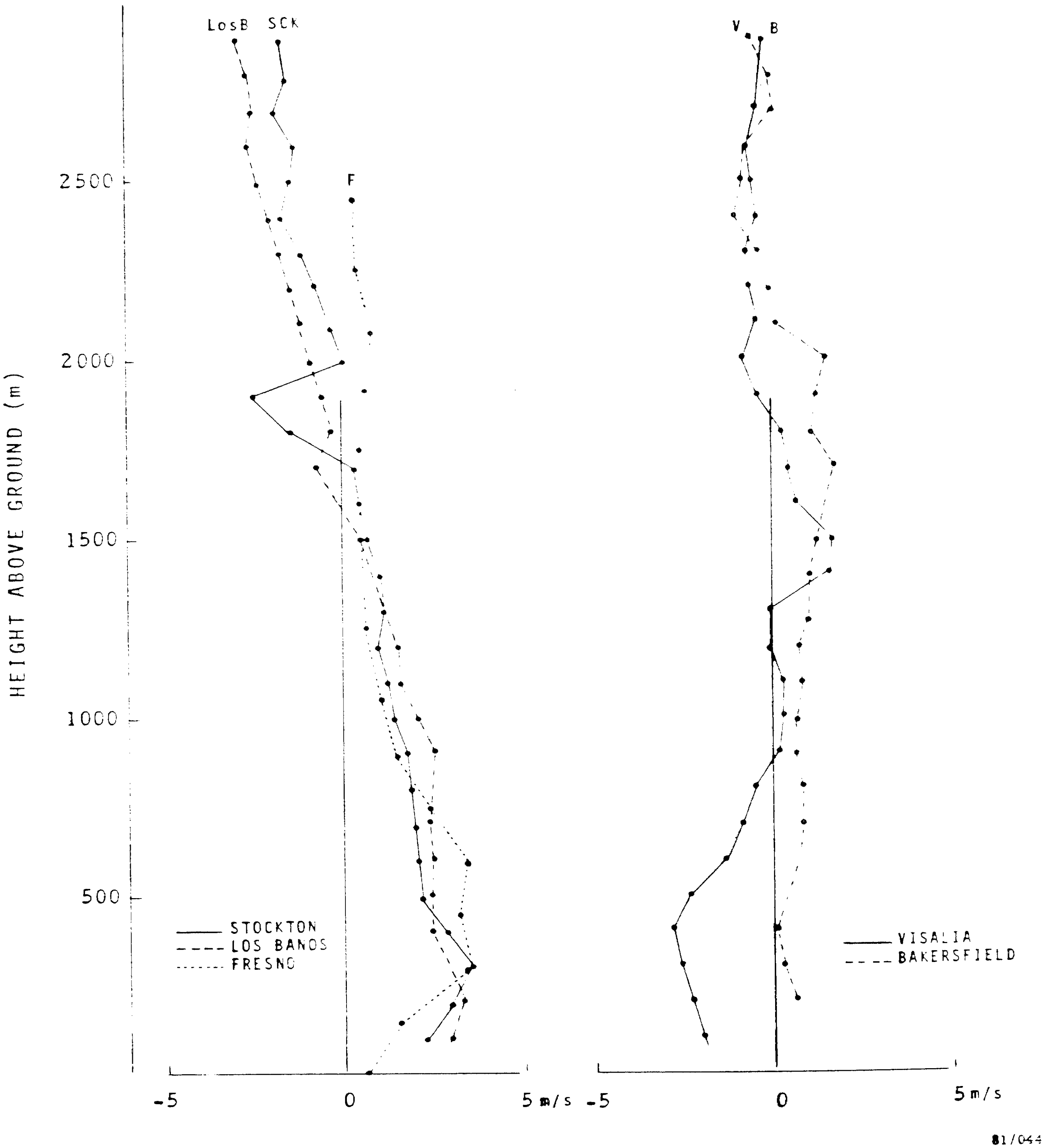

Figure 2.2.4 Average Wind Components Along Valley Axis
September 1979 (05 PDT)

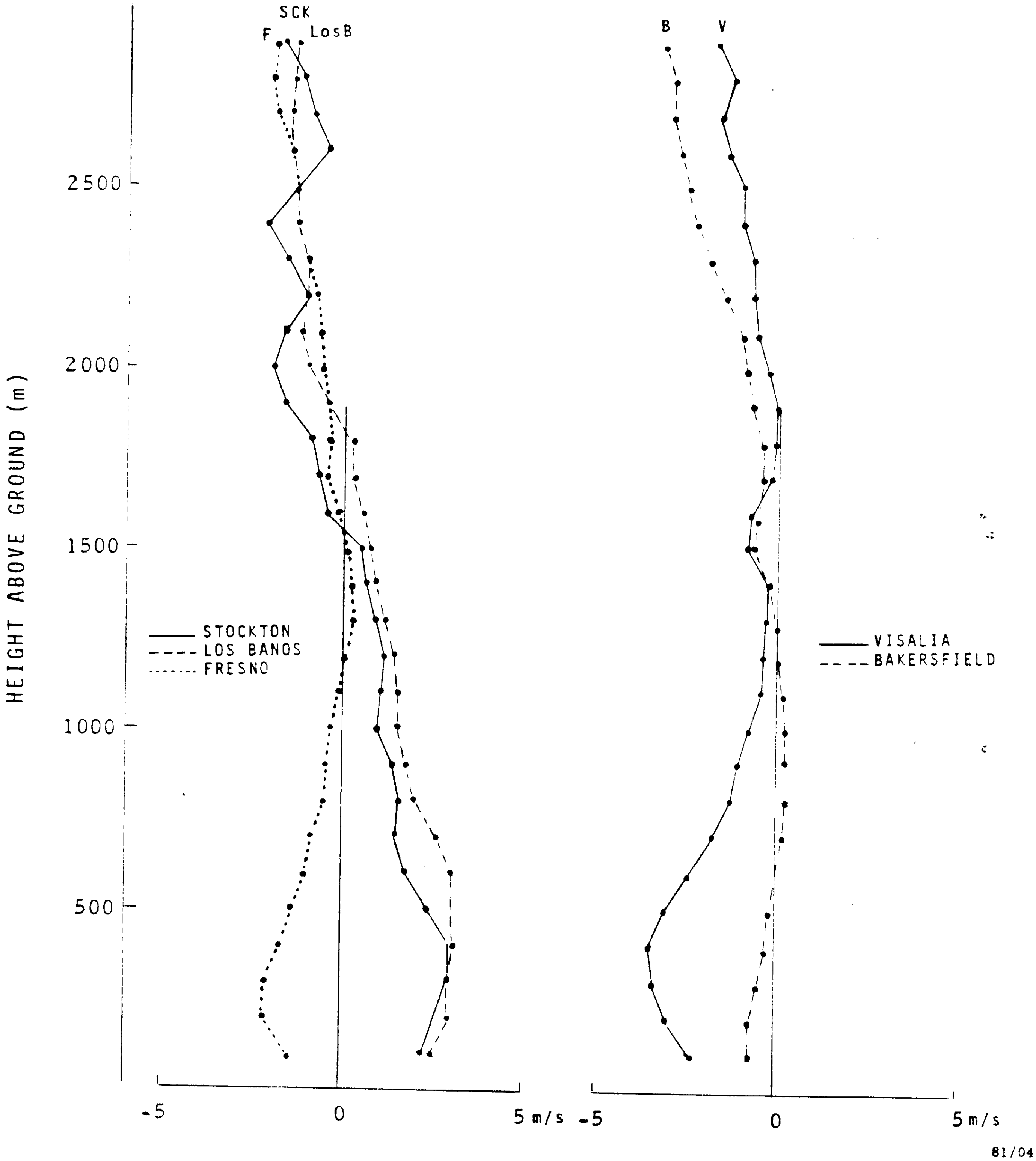

Figure 2.2.5 Average Wind Components Along Valley Axis
September 1979 (09 PDT)

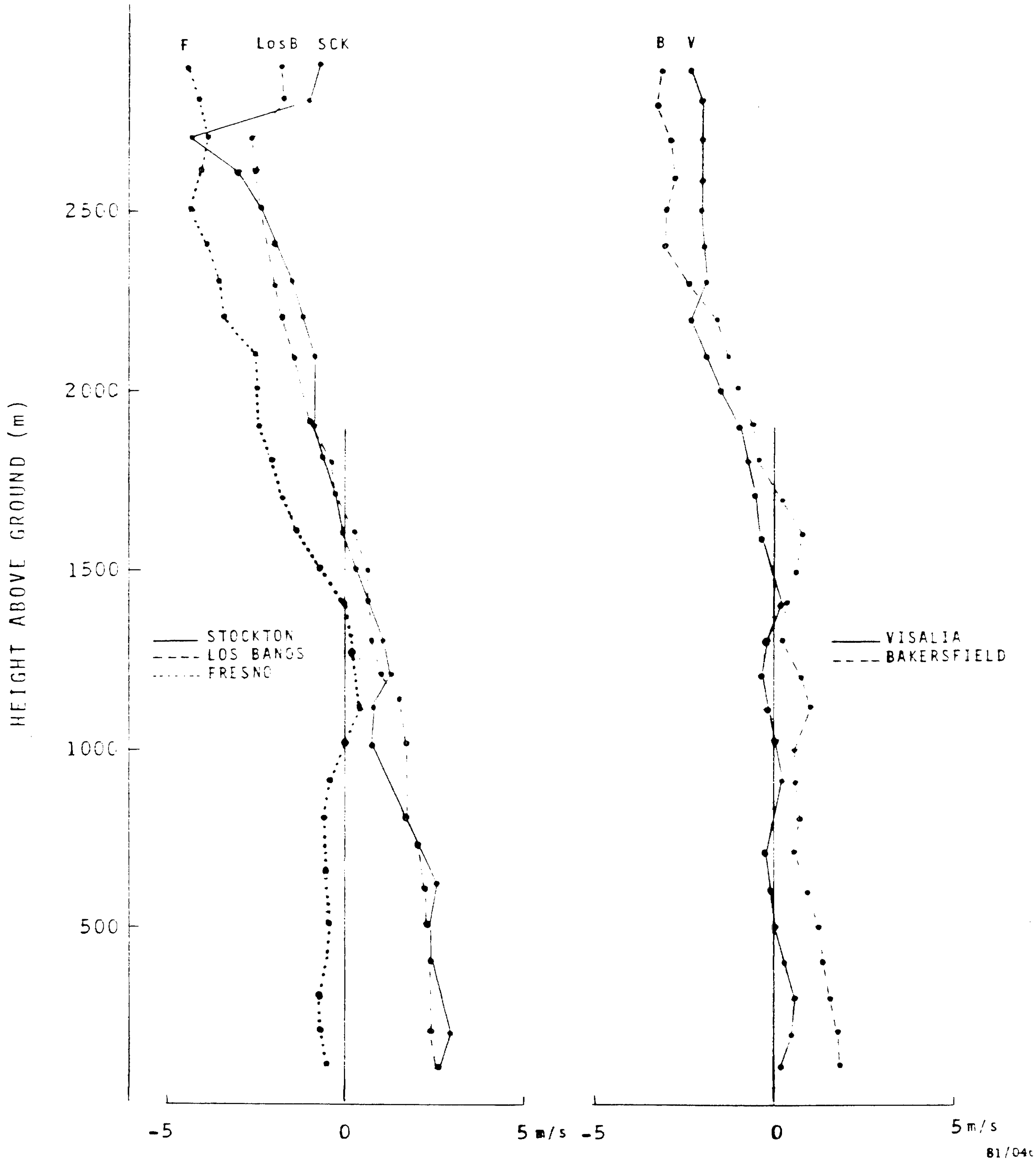

Figure 2.2.6 Average Wind Components Along Valley Axis
September 1979 (13 PDT)

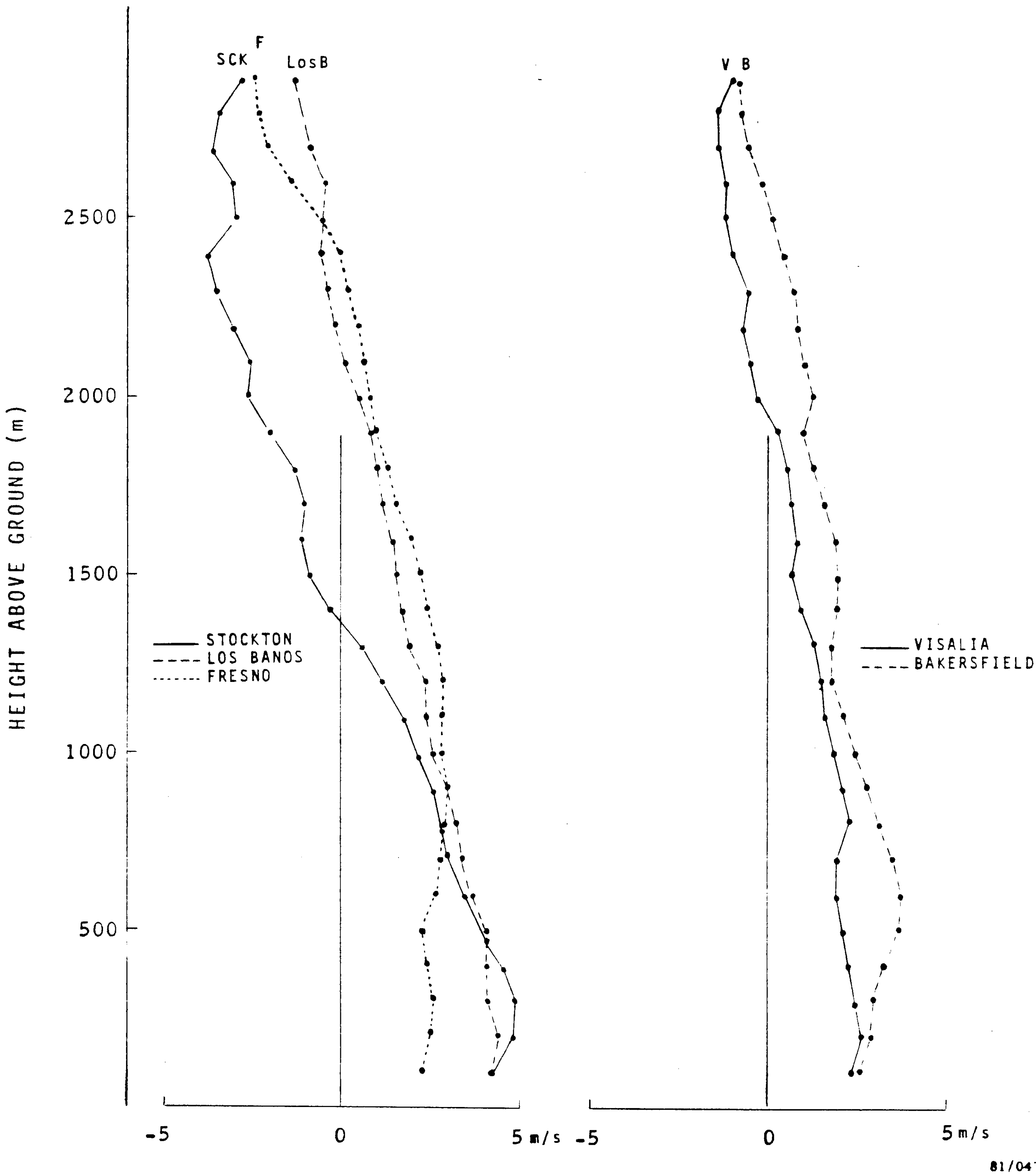

Figure 2.2.7 Average Wind Components Along Valley Axis
September 1979 (17 PDT)

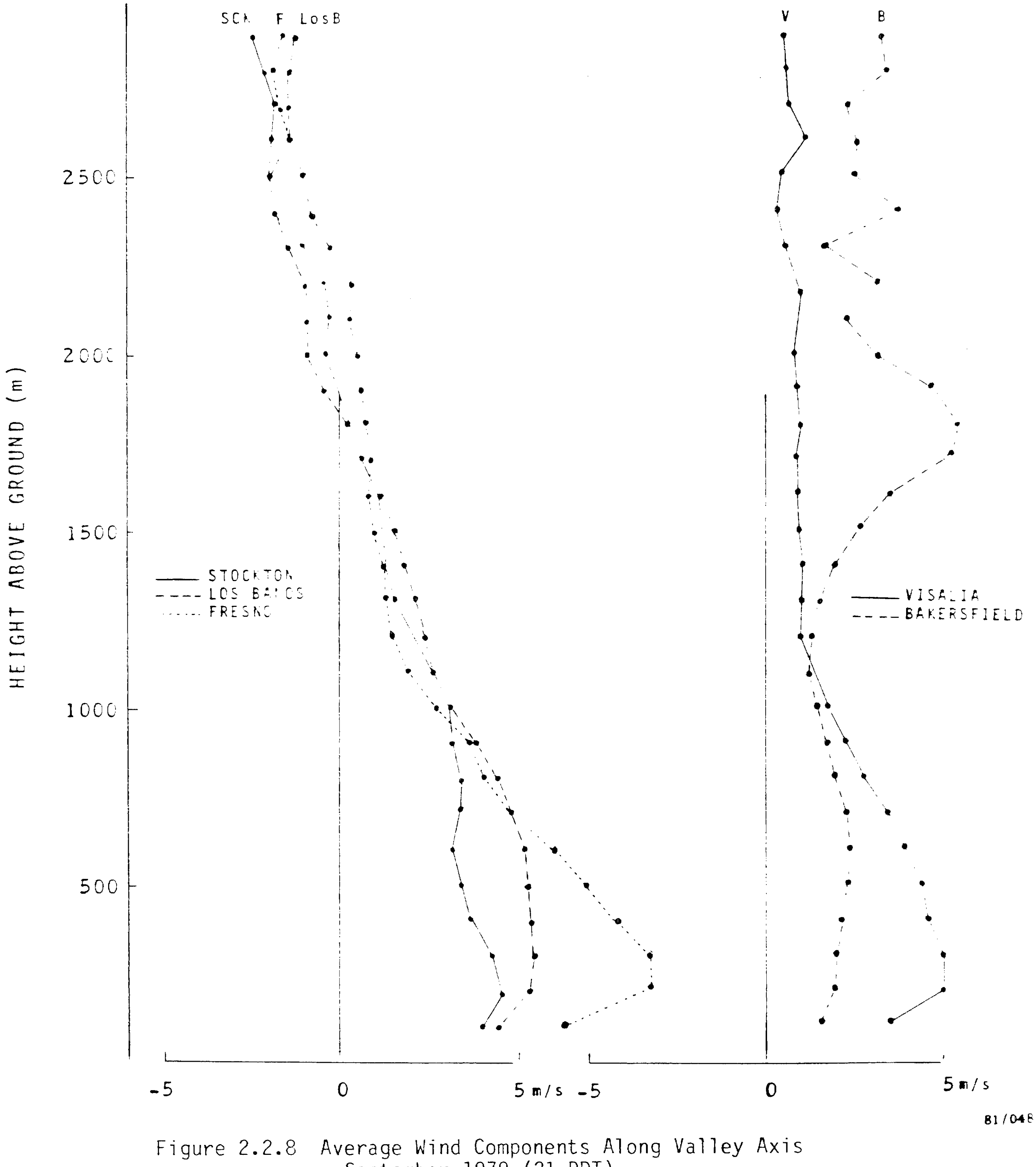

Figure 2.2.8 Average Wind Components Along Valley Axis
September 1979 (21 PDT)

The following features are shown in the figures:

- At 05 PDT the wind component profiles at Stockton, Los Banos and Fresno are very similar. Visalia and Bakersfield show the blocking effects of the terrain at the south end of the valley to a level of about 1200 m (agl). Above that level wind velocities are increased relative to the locations to the north.
- At 09 PDT the wind component profiles at Stockton and Los Banos are similar but the blocking effect has extended as far north as Fresno in the lowest 1200 m. Wind velocities above 1200 m at Bakersfield and Fresno are not substantially different from those farther north.
- At 13 PDT the wind profile at Fresno in the lowest layers is still reduced under the influence of the remnants of the Fresno Eddy. Low-level winds at Visalia and Bakersfield return toward a normal, northwesterly flow but still indicate slightly reduced values.
- All profiles at 17 PDT are similar in the low levels. Stockton, however, shows a stronger southerly flow at higher levels than any of the other locations.
- At 21 PDT evidence of the nocturnal jet is apparent in the low levels at Fresno. Development of the blocking flow and incipient Fresno Eddy appear in the Bakersfield profile to an altitude of 1200 m (agl). Above this level wind components show substantial increases relative to the other locations.

These features indicate the development of a blocking flow in the southern part of the valley as a result of stabilizing air in the low levels and the inability of the stable air to rise over the terrain. A cyclonic eddy forms in the southern part of the valley during the night and frequently spreads northward as far as Fresno by forenoon of the following day. Some of the air approaching the eddy from the northwest is deflected upward over the eddy where it can pass out of the valley to the southeast.

An example of the eddy development is shown in Figures 2.2.9 and 2.2.10. Northwesterly flow is evident throughout the valley at 21 PDT (Figure 2.2.9). By 05 PDT on the following day a substantial eddy was present, covering the southern end of the valley as far north as Visalia. Of the 22 days when data were available, during September 1979, eddies occurred on 17 days. No eddies were observed on September 4, 8, 18, 24 and 25.

Nocturnal Wind Jet

On most nights a nocturnal wind jet forms in the San Joaquin Valley during September. Figure 2.2.11 illustrates the time sequence of axis component winds at Fresno during the period of September 8-9, 1979.

Low level wind components are seen to increase after 13 PDT, reaching a peak velocity at about 300 m (agl) at 21 PDT. The influence of the Fresno Eddy during the following morning is reflected in the negative (southerly flow) wind components observed at 09 PDT. Depth of the eddy-influenced flow is about 1200 m (agl).

The nocturnal wind jet is formed when air in the low layers stabilizes during the early evening. This stabilization reduces the friction forces in the low layers resulting in significant acceleration of the low-level air in response to the existing pressure gradient forces. During September 1979, a strong jet formed on 14 nights of the available 22 days of data with a moderate jet on four other nights. A further discussion of the nocturnal jet is contained in Volume 2.

2.3 Air Quality

Tables 2.3.1 and 2.3.2 give the maximum hourly concentrations of various parameters observed during the September 1979 intensive field program. Concentrations were observed at Reedley (RI), Arvin (RI) and Lost Hills (RI) by Rockwell International vans. The remainder of the concentration data were obtained from CARB Air Quality Data. Similar data for the months of September 1977 and 1978 are shown in the tables for comparison.

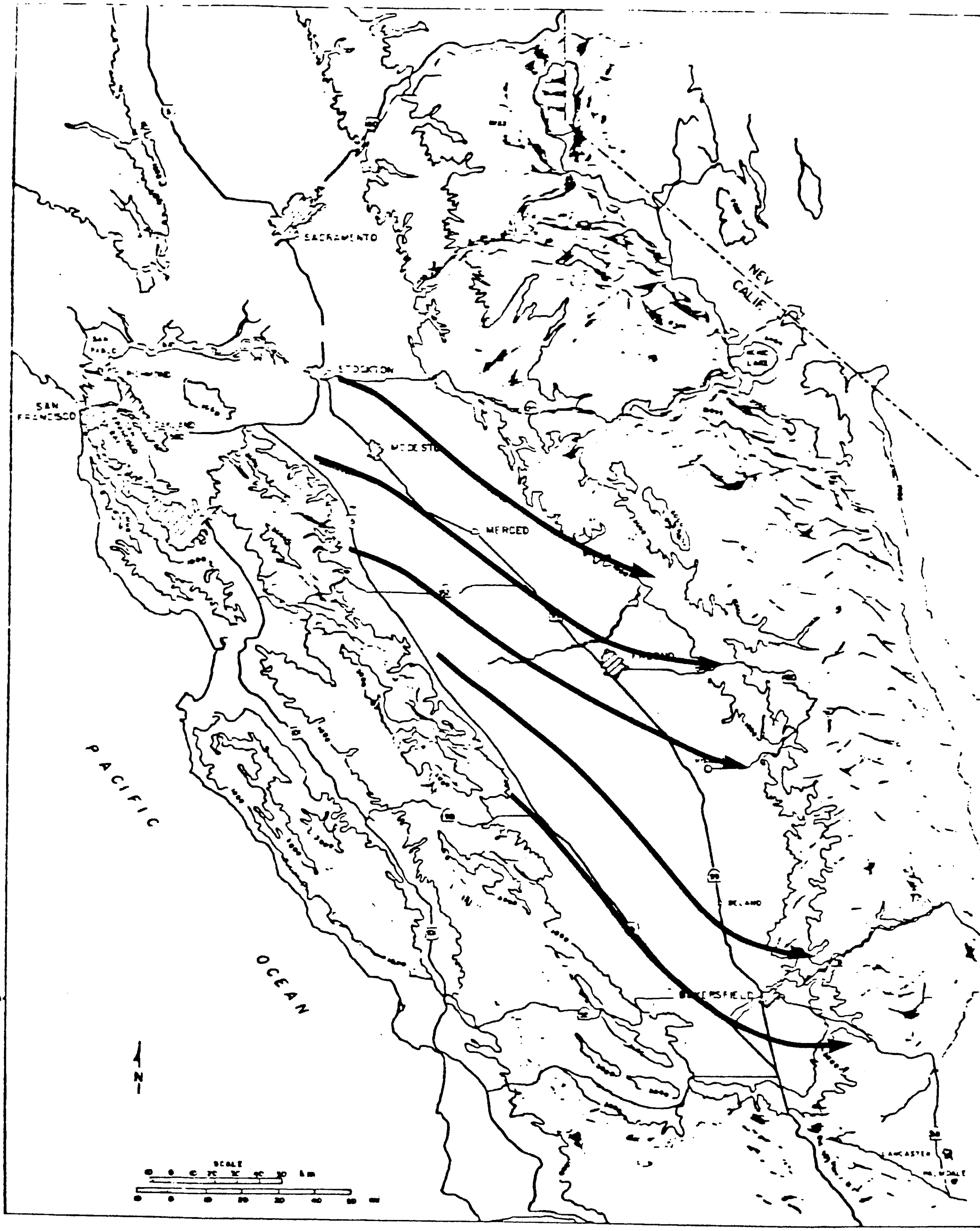

Figure 2.2.9 1000 Ft-agl Streamlines - 17 September 1979 (21 PDT)

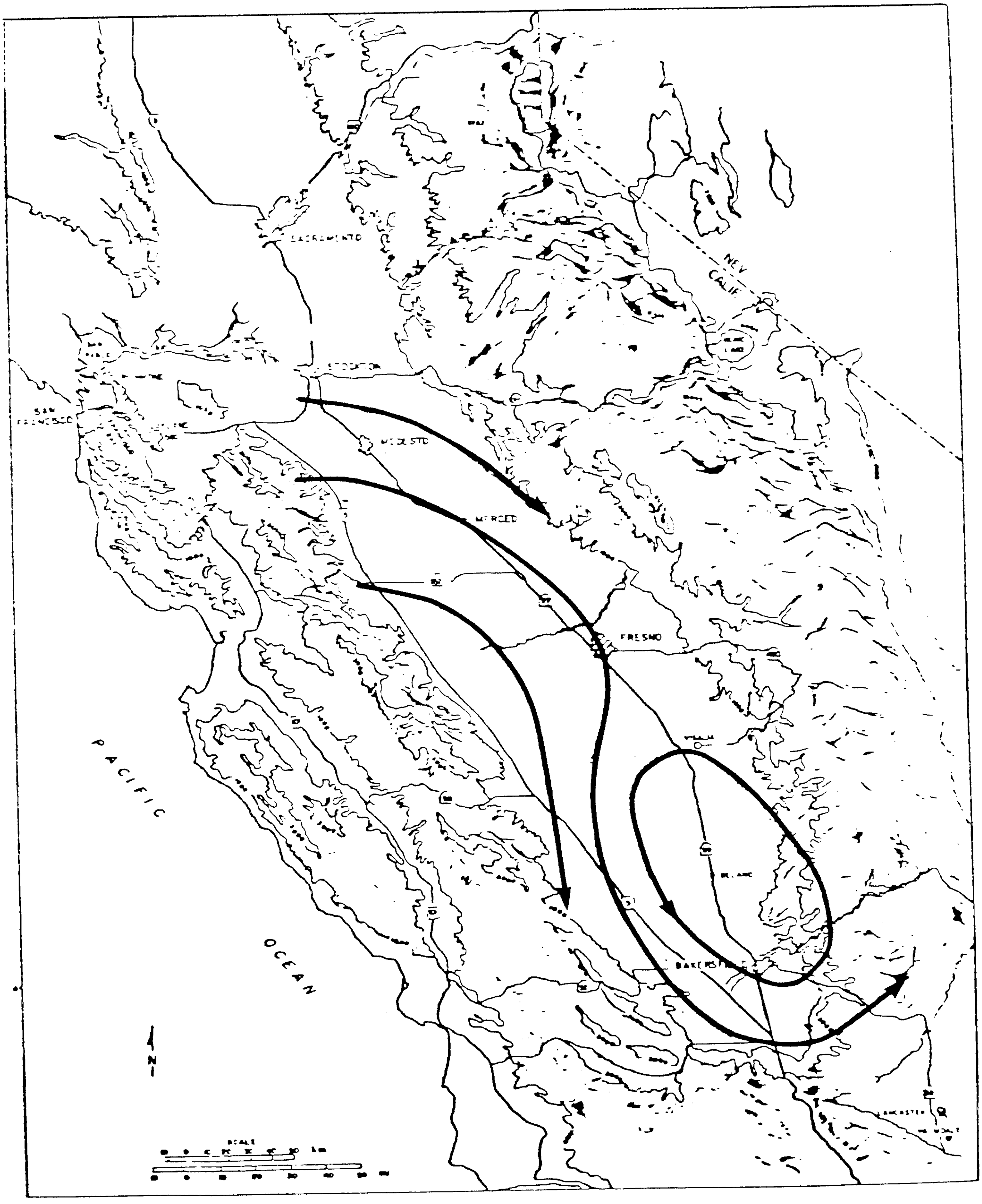

Figure 2.2.10 1000 Ft-agl Streamlines - 18 September 1979 (05 PDT)

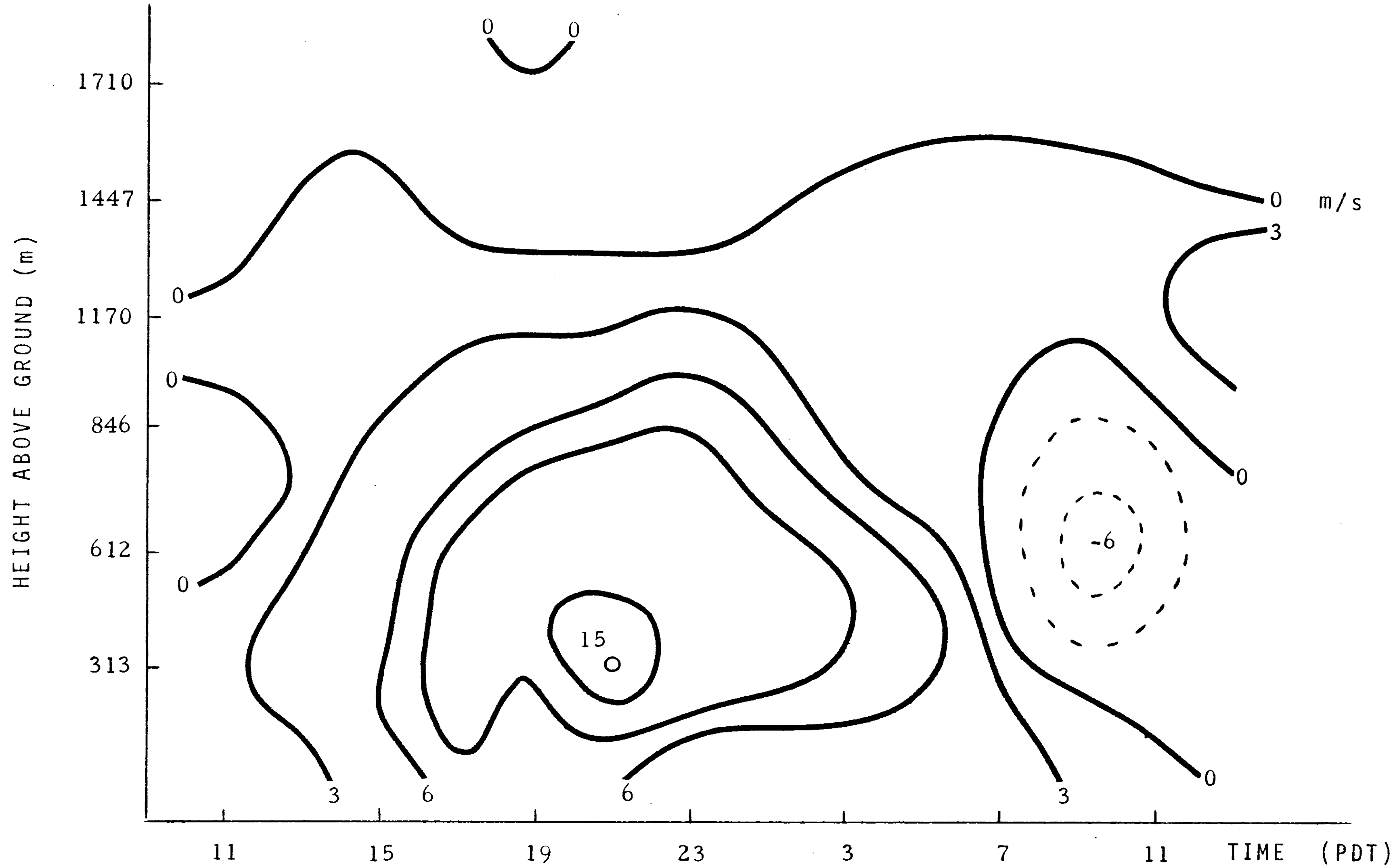

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Figure 2.2.11 Component Winds Along Valley Axis (Fresno)
September 8-9, 1979

Table 2.3.1

MAXIMUM HOURLY CONCENTRATIONS (ppm)
SEPTEMBER

	O_3			CO		
Location	1977	1978	Field 1979	1977	1978	Field 1979
Bakersfield	.12	.15	.11	8	9	5
Coalinga	.09	.07	.09		2	3
Five Points	.10	.08	.07	2	1	2
Fountain Springs		.13	.12			
Squaw Valley	.11	.13				
FNO-Butler						
FNO-CSU		.14	.18		11	6
FNO-Downtown						
FNO-Olive	.13	.14	.13	13	11	9
Hanford	.10		.14			
Lindsay	.11	.12				
Los Banos	.10	.13	.08			
McKittrick						
Merced	.12	.12		4	5	
Modesto	.12		.13	7	6	7
Oildale		.14	.14			
Shaver Lake	.12	.09	.13		1	1
Stockton	.13		.12	8		5
Taft	.10	.11				
Turlock	.18	.14	.13			
Visalia	.09	.10	.13	7	7	8
Reedley (RI)			.16			1.4
Arvin (RI)			.17			
Lost Hills(RI)						

Table 2.3.2

MAXIMUM HOURLY CONCENTRATIONS (ppm)
SEPTEMBER

	NO_x			SO_2		
Location	1977	1978	Field 1979	1977	1978	Field 1979
Bakersfield	.39	.39	.39	.06	.07	.05
Coalinga	.06	.07	.10			.02
Five Points				.03	.04	
FNO-Downtown						
FNO-Olive	.55	.46	.41	.03	.03	.02
McKittrick						
Merced	.29	.26				
Modesto	.44	.45	.40		.02	.08
Oildale		.20			.16	.13
Stockton	.41		.31			
Visalia	.31	.20	.27			.02
Reedley (RI)			.04			.01
Arvin (RI)			.07			.01
Lost Hills (RI)			.11			.01

Comparison of the maximum hourly data in Tables 2.3.1 and 2.3.2 indicates that ozone concentrations were very similar in all three years. Some of the larger urban areas, however, appeared to receive slightly lower peak concentrations of NO_x and CO during the September 1979 period. In spite of this, conditions during the field program appeared to be representative of typical September pollutant episode conditions.

Ozone

Peak hourly concentrations of ozone are shown in Table 2.3.1. A maximum value of .18 ppm was recorded at Fresno in September 1979 compared with peak values of .18 ppm (Turlock) in September 1977 and .15 ppm (Bakersfield) in September 1978. Maximum concentrations in September 1979 were relatively uniform throughout the valley but with slightly lower values (less than .10 ppm) along the western side. Peak concentrations were generally lower than observed in July. There was little apparent trend in peak concentrations over the three-year period (1977-79).

CO

Maximum CO concentrations indicate the large influence of urban areas. Bakersfield and Fresno show hourly concentrations of 8-13 ppm during the three-year period (1977-79). Visalia and Modesto also show relatively large values. Rural areas and the western side of the valley, however, indicate peak concentrations of 1-3 ppm. In particular, the peak value at Reedley was only 1.4 ppm, indicating considerable dilution of the Fresno urban plume. Peak hourly concentrations of CO in the valley in September are considerably higher than observed in July. This is likely to be attributable to the low-level stability during September.

Nitrogen Oxides

Peak concentrations of nitrogen oxides during September occur at urban centers, Bakersfield, Fresno and Modesto. The western side of the valley showed much lower peak concentrations (of the order of .10 ppm). There appeared to be little, if any, trend in maximum hourly concentrations during the three-year period. Peak values in September are consistently higher than those observed in July, in agreement with the CO concentrations.

Sulfur Dioxide

Oildale and Bakersfield show the highest hourly sulfur dioxide concentrations during September. In agreement with previous comparisons, the highest hourly values exceeded those observed in July. .16 and .13 ppm were recorded at Oildale during September 1978 and September 1979, respectively. The balance of the maximum hourly concentrations were less than .10 ppm throughout the valley.

Hydrocarbons

Non-methane hydrocarbons were sampled at Arvin and Lost Hills during September 1979. Samples were obtained and analyzed by the Atmospheric Testing Branch, California Air Resources Board (El Monte). Samples were analyzed for C_2 to C_{10} in most cases.

Table 2.3.3 gives the average concentrations at 06-09 PST of NMHC by hydrocarbon type for both Arvin and Lost Hills. Total NMHC averaged about .3 ppm at Arvin and 2.6 ppm at Lost Hills. The Lost Hills samples were rich in the paraffins and reflect the influence of the nearby oil fields. At Arvin a more balanced distribution of hydrocarbon types was observed. Automobile contributions were considered to be small as suggested by the low values of acetylene at both locations. The reactive olefin concentrations were low in both areas.

NO_x concentrations were measured at Arvin and Lost Hills by the Rockwell International vans. NO_x values from 06-09 PST averaged 11 ppb at Arvin and 18 ppb at Lost Hills according to the Rockwell data. For the same period, Bakersfield NO_x concentrations averaged about 100 ppb. If the Rockwell NO_x data are used average NMHC/NO_x ratios of about 15 would be found at Arvin and 145 at Lost Hills. Use of the Bakersfield data for Arvin would reduce these numbers by a factor of 10.

NMHC values at Arvin were relatively low and the reactive component was also quite low. At Lost Hills the NMHC values were high but the reactive component was low. Under these conditions a significant ozone development would not be expected in spite of the large NMHC concentrations.

Table 2.3.3

AVERAGE NMHC CONCENTRATIONS (ppb)
SEPTEMBER 1979 (06-09 PST)

Name Number of Samples	Arvin 22	Lost Hills 22
Ethane	44	650
Ethylene	10	10
Acetylene	11	5
Propane	45	650
Propylene	4	5
Isobutane	19	261
N-Butane	42	421
Isopentane	38	194
N-Pentane	36	203
M-Pentane	46	212
Total	295	2611

Time of Peak Hourly Concentrations

Table 2.3.4 gives the time that peak concentrations of ozone and NO_x were observed at various stations in the southern part of the valley during September 1979. The principal periods of peak concentrations are shown together with an indication (in parentheses) that peaks were also observed at other times of day.

Table 2.3.4

TIME OF MAXIMUM CONCENTRATION (PST)
SEPTEMBER 1979

	O_3	NO_x
Reedley (RI)	15-17	06-09 (19-23)
Arvin (RI)	15-17 (12-14)	03-09
Lost Hills (RI)	12-14 (15-17)	19-21 (05-08)
Oildale	11-13	
Bakersfield	13-15	19-23

Principal peak occurrences at Oildale and Lost Hills suggest an association with local sources where the ozone peak occurs about noon. All other stations indicate transport into the location from another source area. This is particularly true for Reedley and Arvin which are receptor areas for Fresno and Bakersfield, respectively. The relatively late peak at Bakersfield suggests the possibility that the Oildale source region may contribute to this peak.

Peak NO_x concentrations occur in the early morning or evening. Emissions from local sources accumulate during these periods as the wind decreases and low-level stability dominates the dispersion conditions.

2.4 Particulates

2.4.1 Total Particle Composition

Average total particle concentrations measured during the September 1979 intensive are listed in Table 2.4.1. Average mass concentrations at Fresno and Arvin were identical, while the average at Lost Hills was about 25 percent lower. The major components at the three sites were silicon, carbon, aluminum, sulfate, and nitrate. The largest differences between sites were in the average carbon and sulfate concentrations. The average carbon levels at Fresno and Arvin were similar, while the average at Lost Hills was significantly lower. Sulfate was highest at Arvin, while the averages at Lost Hills and Fresno were similar.

Table 2.4.1

AVERAGE TOTAL PARTICLE CONCENTRATIONS
MEASURED DURING SEPTEMBER 1979

Component	Fresno (13 Samples) $(\mu g/m^3)$	Fresno (13 Samples) (% Mass)	Arvin (15 Samples) $(\mu g/m^3)$	Arvin (15 Samples) (% Mass)	Lost Hills (21 Samples) $(\mu g/m^3)$	Lost Hills (21 Samples) (% Mass)
Mass	118		118		88.5	
$SO_4^=$	4.8	4.1	7.5	6.4	4.3	4.9
NO_3^-	3.4	2.9	3.6	3.1	2.3	2.6
NH_4^+	1.4	1.2	2.3	2.0	1.2	1.4
C^+	9.2	4.8	8.1	6.9	5.4	6.1
Al	7.8	6.6	7.0	5.9	5.2	5.9
Si	21	17.6	20	16.9	17	19.2
Cl	0.18	0.2	0.17	0.1	0.27	0.3
K	1.9	1.6	1.8	1.5	1.2	1.4
Ca	1.8	1.5	2.4	2.0	2.4	2.7
Ti	0.44	0.4	0.51	0.4	0.29	0.3
V	0.034	0.03	0.040	0.03	0.026	0.03
Fe	4.3	3.6	5.2	4.4	3.0	3.4
Ni	0.014	0.01	0.027	0.02	0.013	0.01
Zn	0.055	0.05	0.044	0.04	0.038	0.04
Br	0.086	0.07	0.034	0.03	0.026	0.03
Pb	0.42	0.4	0.16	0.1	0.11	0.1
Sum of Chemical Components	56.8	48.2	58.9	49.7	42.8	48.3

Vanadium and nickel concentrations were highest on the average at Arvin and, suprisingly, lowest at Lost Hills. Lead and bromine were highest at Fresno.

2.4.2 Source Contributions to Total Particle Concentrations

Averages of the estimated contributions of the emission types to total particle samples for the September sampling period are shown in Table 2.4.2.

Table 2.4.2

ESTIMATED CONTRIBUTIONS OF SOURCE TYPES
TO AVERAGE TOTAL PARTICLE MASS DURING SEPTEMBER 1979

Source Type	Location: Fresno 13 Samples ($\mu g/m^3$)	Fresno (%)	Arvin 14 Samples ($\mu g/m^3$)	Arvin (%)	Lost Hills 20 Samples ($\mu g/m^3$)	Lost Hills (%)
Cultivated land	96.0	81.0	101.0	87.0	40.0	44.0
Uncultivated	-*	-*	1.0	1.0	38.0	42.0
Motor vehicles (primary)**	1.0	1.0	0.5	0.4	0.4	0.4
Oil combustion (primary)†	0.3	0.3	0.5	0.4	0.3	0.3
$(NH_4)_2 SO_4$	3.0	3.0	6.0	5.0	3.0	3.0
$NH_4 NO_3$	4.0	3.0	4.0	3.0	3.0	3.0
Unidentified C	8.0	7.0	8.0	7.0	5.0	5.0
Sum	112.0	95.0	121.0	104.0	90.0	99.0
Measured Mass	118.0		116.0		91.0	

* Emission type not included in calculations. Contribution is probably zero.

** Includes only motor vehicle exhaust. Resuspended road dust is not distinguishable from cultivated and uncultivated land. Conversion of NO_x emissions to nitrate is included with $NH_4 NO_3$.

† Sulfate formed from SO_2 emissions and NO_3 formed from NO_x emissions are included with $(NH_4)_2 SO_4$ and $NH_4 NO_3$.

Fugitive emissions of crustal-like materials accounted for more than 81 percent of the measured mass at all three sites. Both the mass fractions and concentrations from these emissions were substantially larger than during the November-December period. This increase may have resulted from one or more of the following factors:

- drier soil conditions, which could lead to enhanced suspension of dust,
- higher wind speeds, which would increase suspension, and
- changes in agricultural activities, such as increased plowing or harvesting.

Additional information beyond that obtained in this study is required to investigate these possibilities further.

Contributions of particles emitted directly by motor vehicles, oil combustion, and of ammonium sulfate and ammonium nitrate formed by conversion of sulfur dioxide and nitrogen oxide emissions were lower at all three sites during the November-December period. This decrease is probably a result of larger dispersion of emissions.

Carbon not accounted for by the other sources in the calculations was lower at Fresno than during the November-December intensive, and about the same at the other two sites.

The source types in the calculations, including excess carbon, accounted for 95 to 104 percent of the average measured mass.

3. Tracer Summaries

3.1 Test 1 5-6 September 1979, Oildale Release (0700-1200 PDT)

3.1.1 Meteorology

General

The synoptic meteorology of the 5-6 September period was characterized by a deepening trough at 500 mb in the eastern Pacific and concurrent development of a ridge over the western U.S. (Figure 3.1.1). Temperatures aloft were slightly above normal and warming (see Figure 2.2.1). At the surface, a weakening weather front was moving onshore in northern California but did not affect conditions in the San Joaquin Valley. A thermal trough was established over the interior of California which resulted in an onshore pressure gradient. Visibilities were generally good in the San Joaquin Valley (>20 miles) and clear skies prevailed. Surface temperatures were near normal for September with Bakersfield reporting a high of 92° on the 5th.

Transport Winds

The surface winds from Oildale during the release are tabulated in Table 3.1.1. During the first four hours, the flow was directed to the north at 1-3 m/s. For the remainder of the release period, the winds were from the southwest, reflecting upslope flow.

Table 3.1.1

SURFACE WINDS AT OILDALE (SAN JOAQUIN TOWER)
5 SEPTEMBER 1979

Time (PDT)	Wind Direction/Speed (m/s)
0700	170/1.3
0800	170/2.2
0900	170/2.7
1000	195/2.7
1200	235/1.3

WEDNESDAY, SEPTEMBER 5, 1979

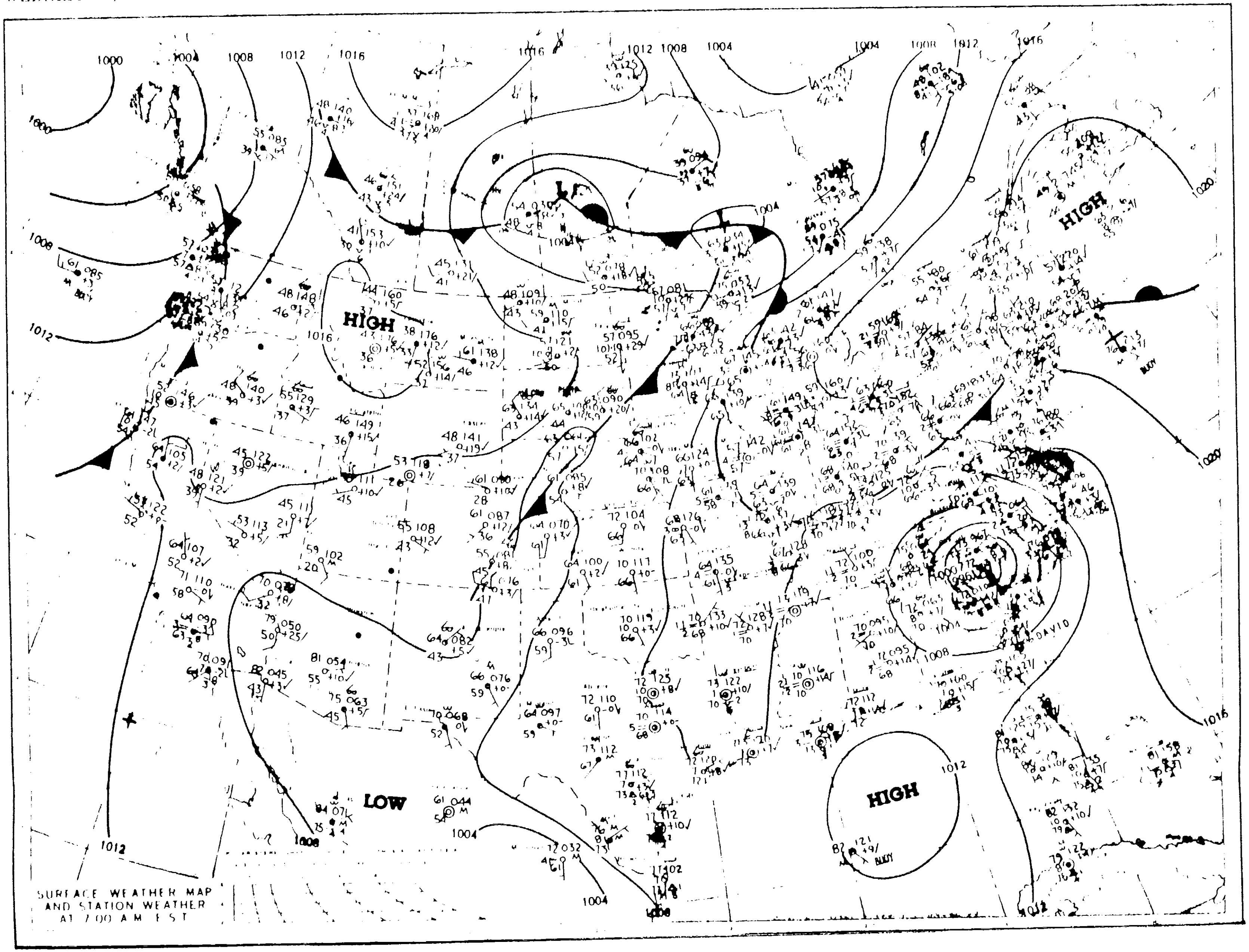


Figure 3.1.1 Surface Weather Chart - 5 September 1979 (05 PDT)

The vertical and temporal characteristics of the winds aloft can be examined with the time-height cross section of the pibal observations from Bakersfield shown on Figure 3.1.2. In the lower layers, the flow was from the southeast averaging 2 m/s until approximately 1000 PDT. The winds subsequently shifted to the northwest becoming westerly by 1700 PDT. Maximum speeds in the lower 1000 m were associated with the westerly flow and ranged from 3-5 m/s. By 2100 PDT the flow had again shifted to southeasterly. During the transition periods, wind speeds decreased to less than 1 m/s.

Streamlines constructed from the winds at 1000 ft-agl were used to examine the transport on a regional basis. The streamline analysis of the 0700 PDT winds in Figure 3.1.3 depicts the wind field early in the tracer release period. A cyclonic flow pattern existed in the southern half of the valley. Down valley flow or transport to the northwest extended past Visalia. The regional flow pattern during the early afternoon (1300 PDT) is shown on Figure 3.1.4. Northwest flow generally prevailed throughout the San Joaquin Valley. The winds at Taft and Grapevine were strongly influenced by their proximity to the mountains and show an upslope component. By late afternoon (1900 PDT) the streamlines in the southern valley (Figure 3.1.5) continue to show a strong component directed from the northwest. The major feature of the nighttime flow regime, depicted in Figure 3.1.6 is the stabilization of the atmosphere which forced the streamlines to converge at the southern extreme of the valley. These conditions favor the formation of the Fresno eddy which subsequently developed early in the morning of the 6th (Figure 3.1.7).

Mixing Heights

Mixing heights on September 5-6 were measured by the aircraft as shown in Table 3.1.2. Maximum mixing heights during the afternoon of the 5th exceeded 1000 m. However, a surface layer to 100 m had developed near Bakersfield by the end of the flight.

On the following morning (September 6) mixing heights were in the range of 200-400 m, increasing as the surface layers heated during the late forenoon.

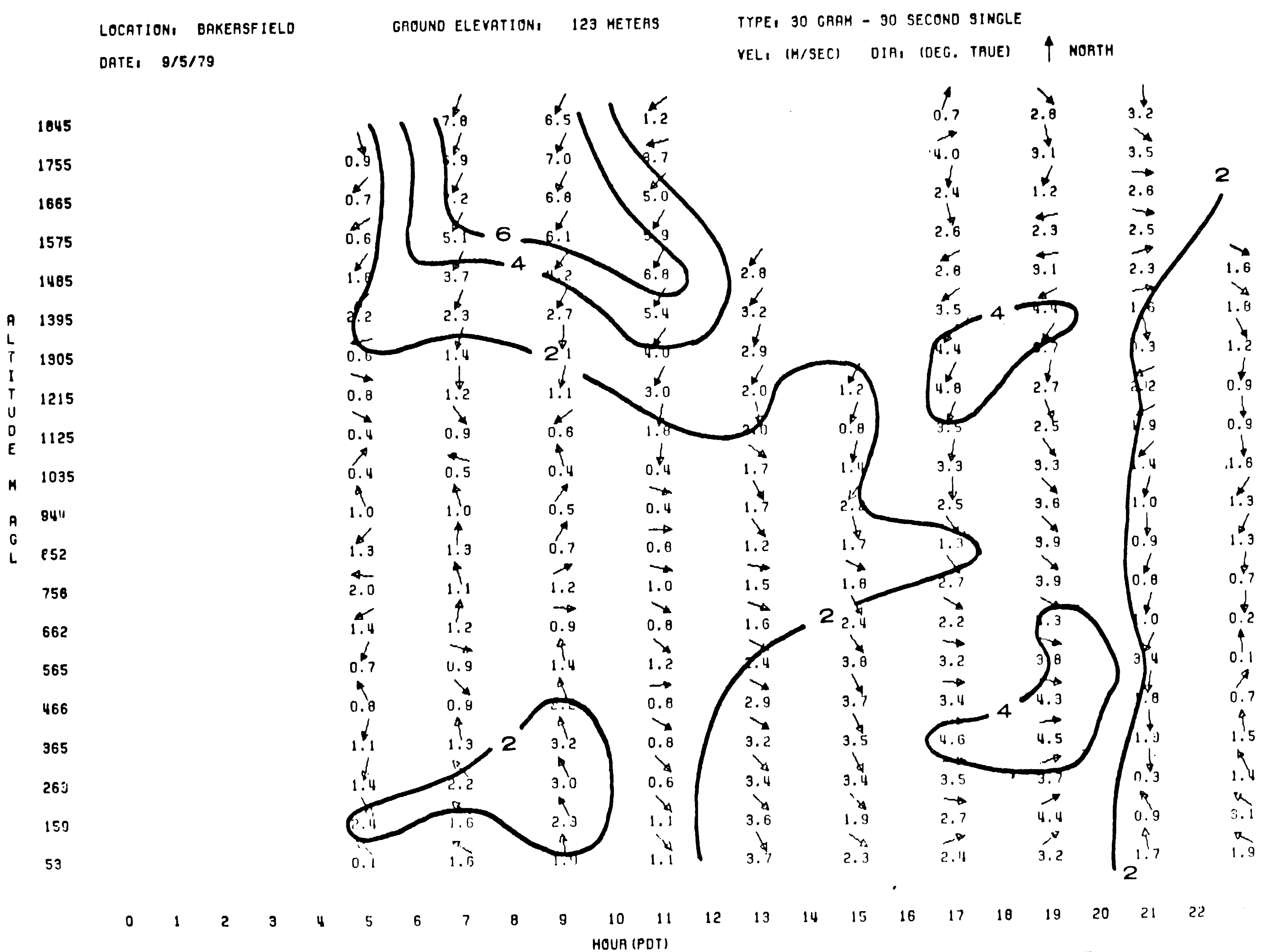


Figure 3.1.2 Time-Height Cross Secti ıf Winds From Bakersfield - 5 September 1979

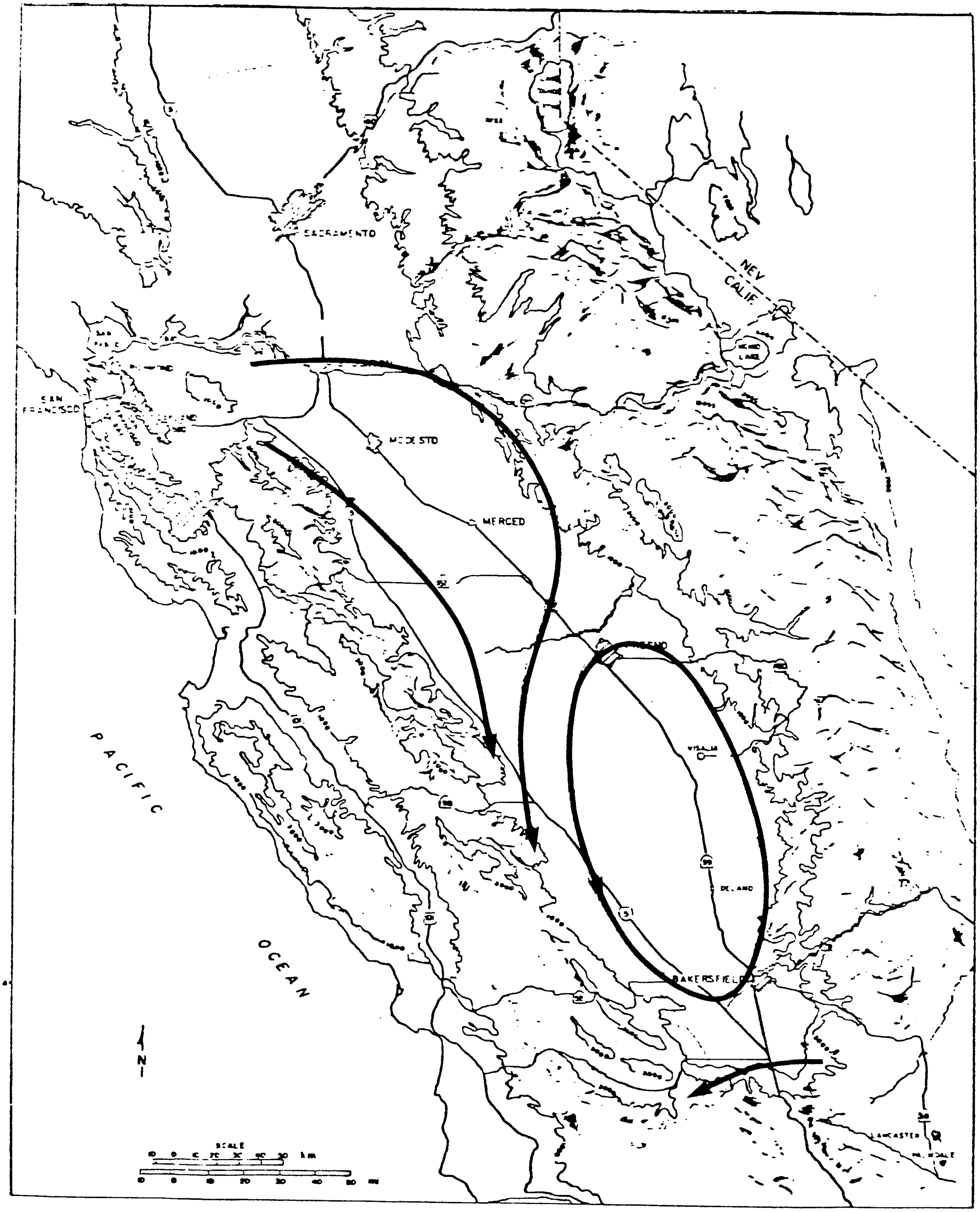


Figure 3.1.3 1000 Ft-agl Streamlines - 5 September 1979 (07 PDT)

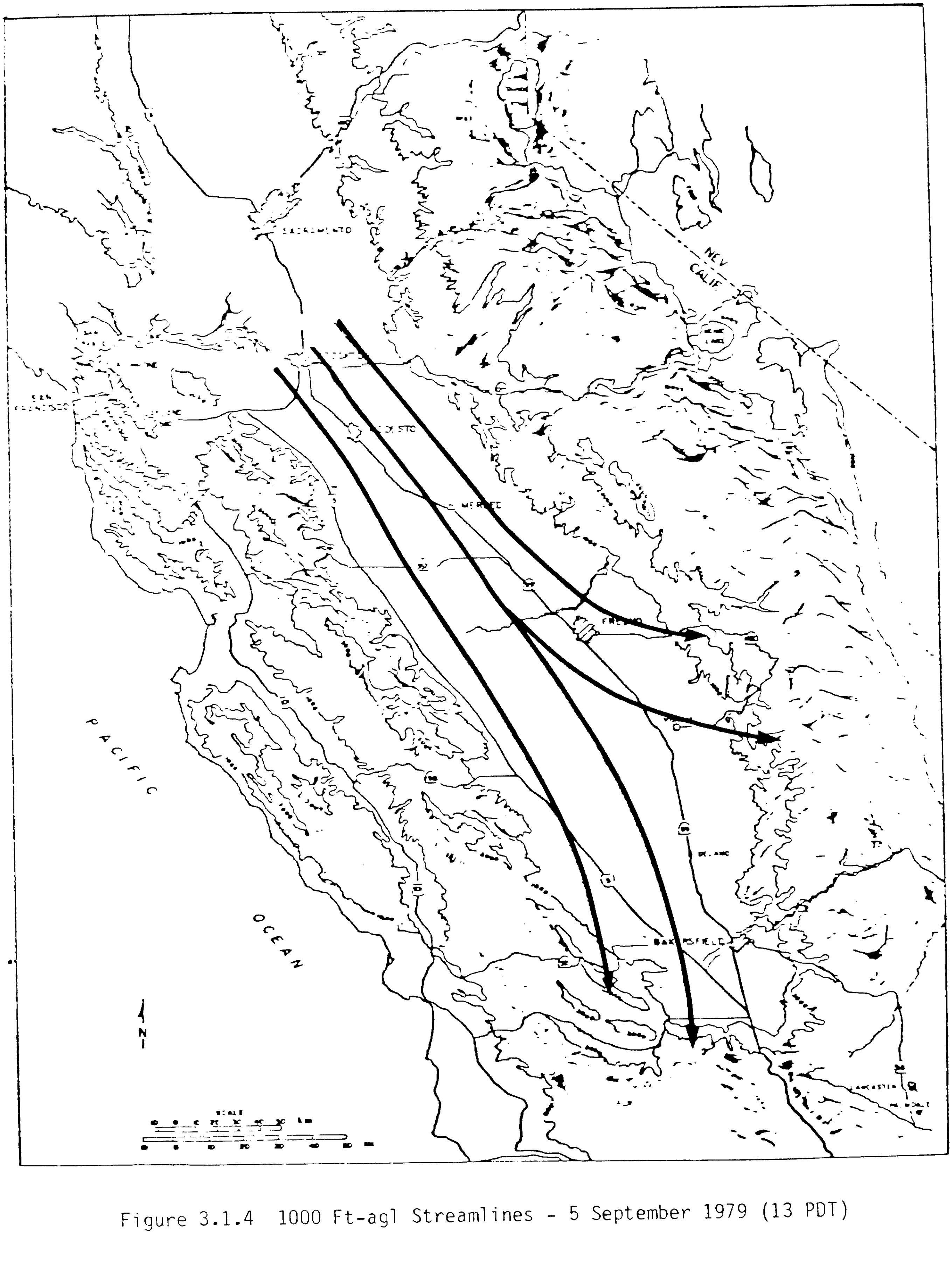


Figure 3.1.4 1000 Ft-agl Streamlines - 5 September 1979 (13 PDT)

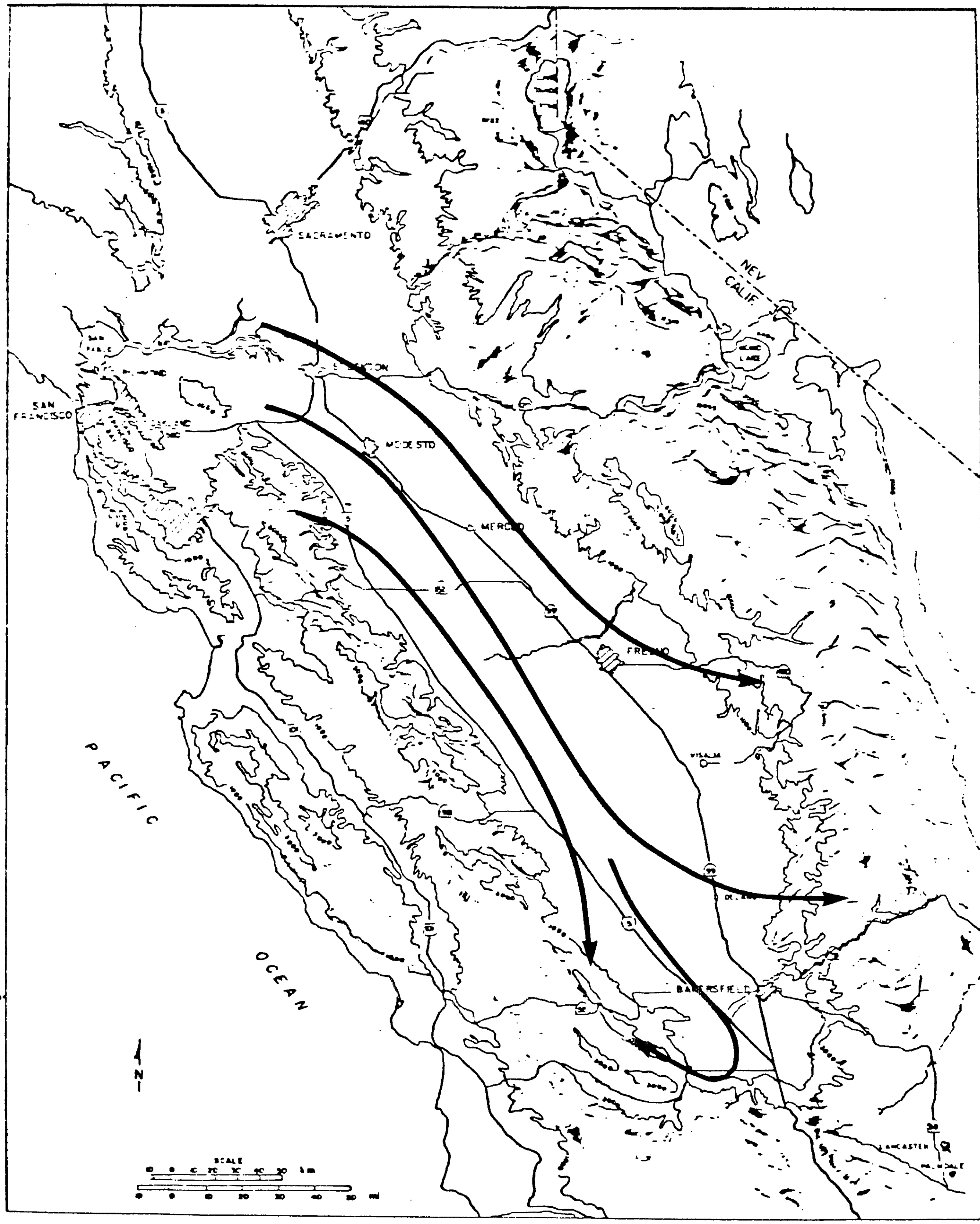


Figure 3.1.5 1000 Ft-agl Streamlines - 5 September 1979 (19 PDT)

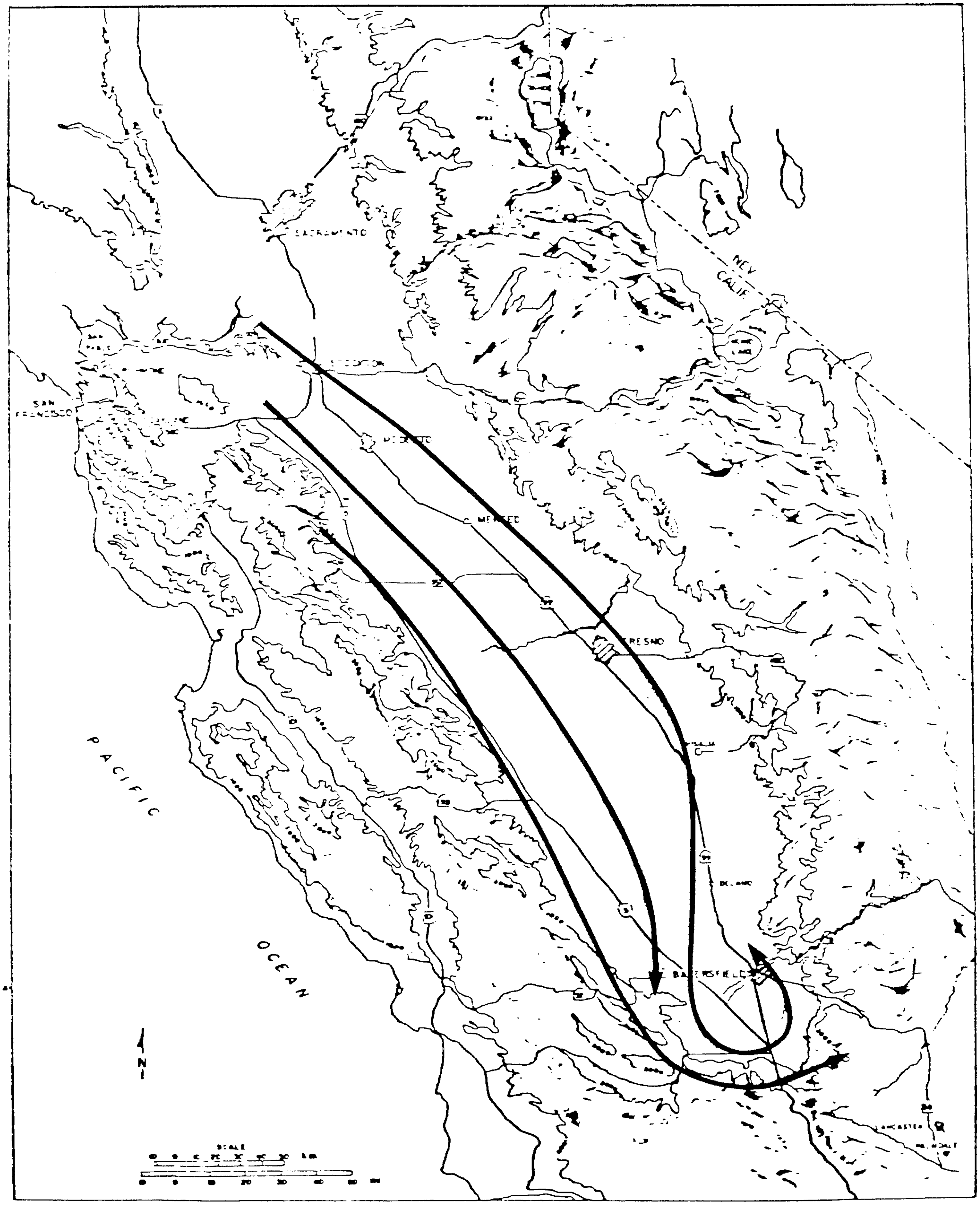


Figure 3.1.6 1000 Ft-agl Streamlines - 6 September 1979 (03 PDT)

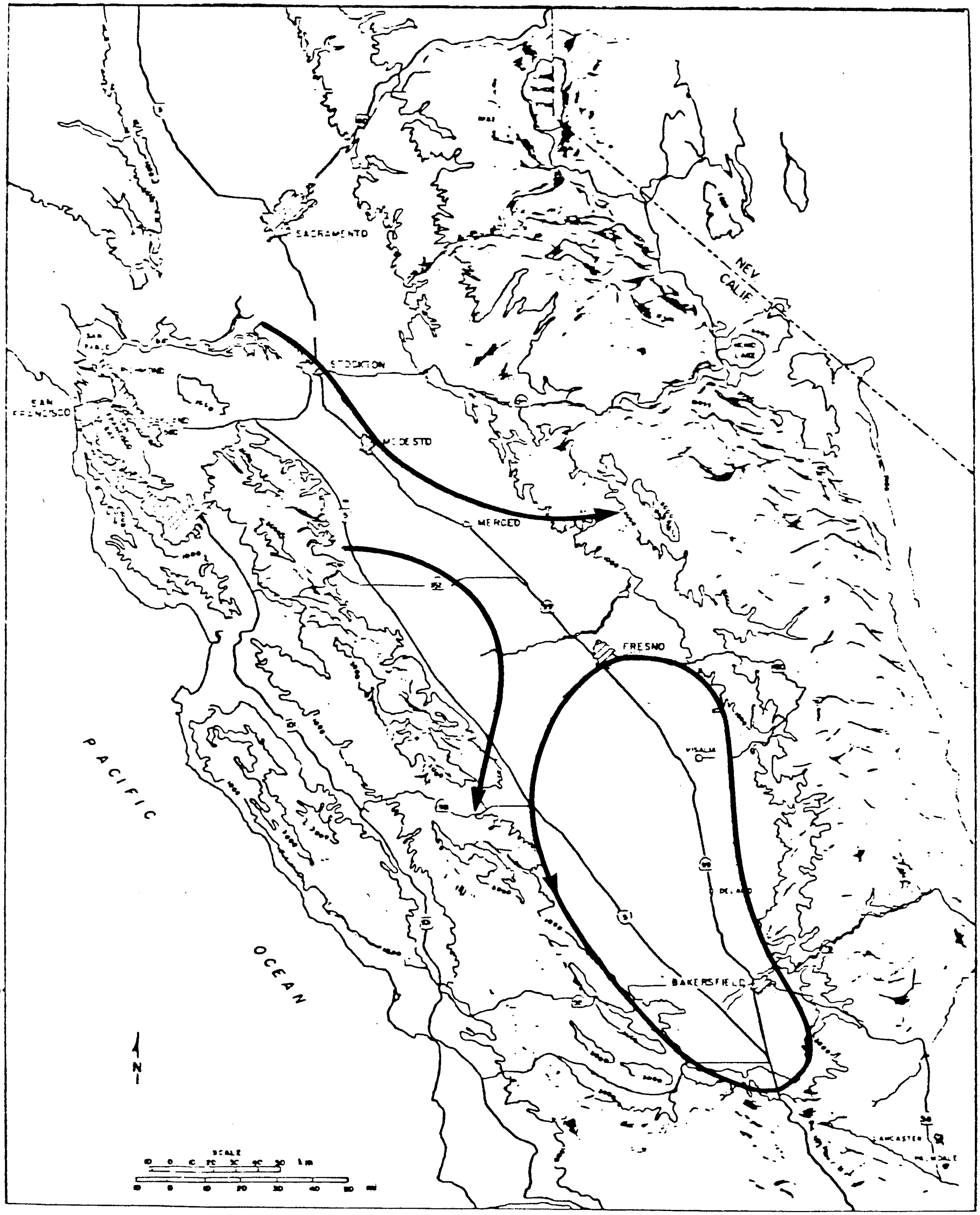


Figure 3.1.7 1000 Ft-agl Streamlines - 6 September 1979 (09 PDT)

Table 3.1.2

AIRCRAFT MIXING HEIGHTS

Time (PDT)	Location *	Mixing Height (m [above ground level])
	September 5, 1979	
1605	4 NW Bakersfield Airport	780
1704	Caliente	1285
1853	4 NW Bakersfield	100 (1260)
	September 6, 1979	
0735	4 NW Bakersfield Airport	330
0828	Caliente	420
0904	Mojave	170
1001	Lake Isabella	400
1042	4 NW Bakersfield Airport	570

(* Distances in miles)

3.1.2 Air Quality

Regional Pollutant Levels

Maximum measured hourly average ozone concentrations for September 5 are shown in Figure 3.1.8. Within the valley, exceedances of the California ambient air quality standard were experienced only at Fresno and Visalia. Maximum concentration within the valley was measured at Miracle Hot Springs (.12 ppm) in the Sierra Nevadas, east of Bakersfield.

Maximum hourly concentrations for CO, SO_2 and NO_x in the valley on September 5 are given in Table 3.1.3. Maximum values observed at the three Rockwell International vans are also shown. In general, concentrations were relatively low throughout the valley.

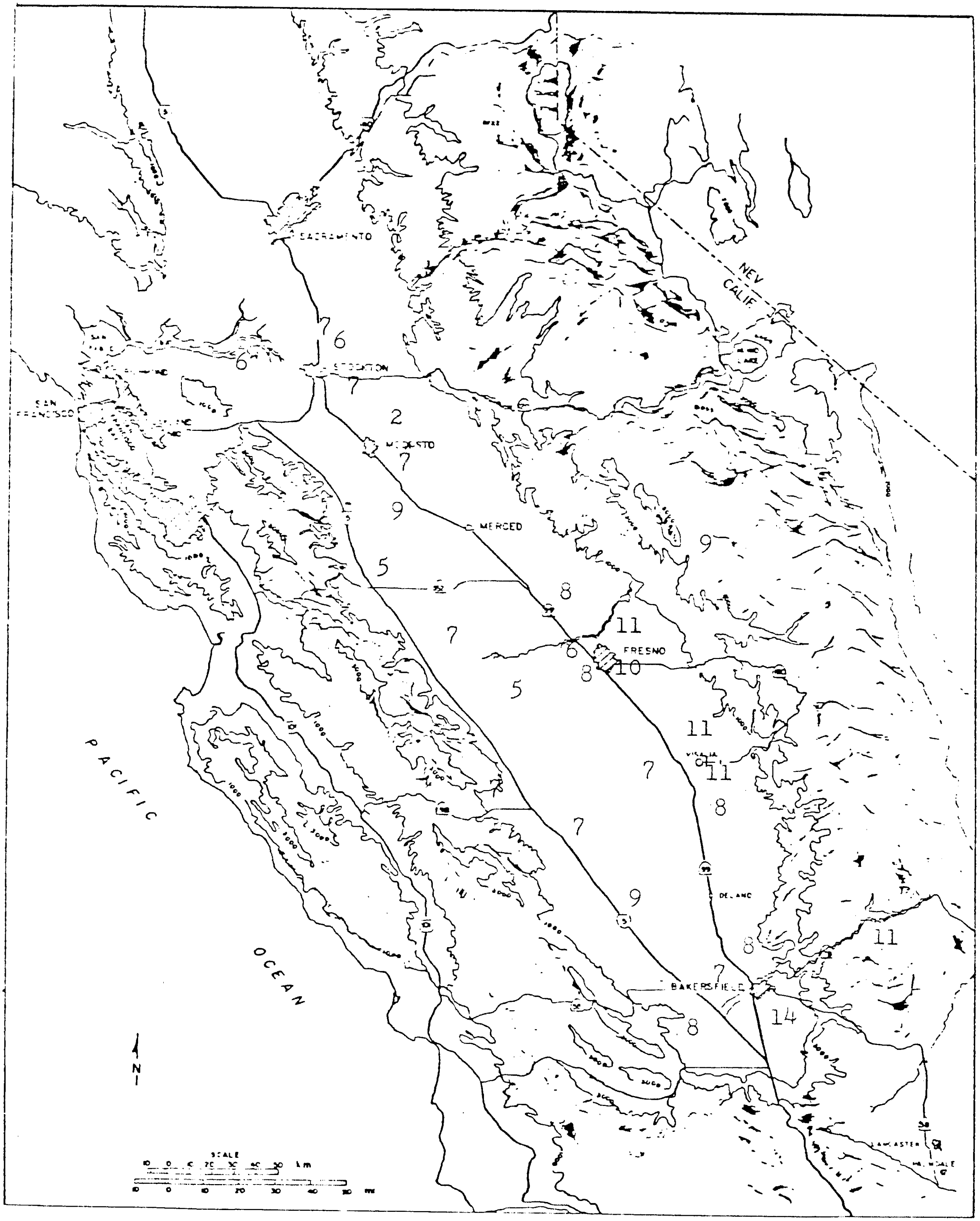


Figure 3.1.8 Maximum Hourly Ozone Concentrations (pphm) - 5 September 1979

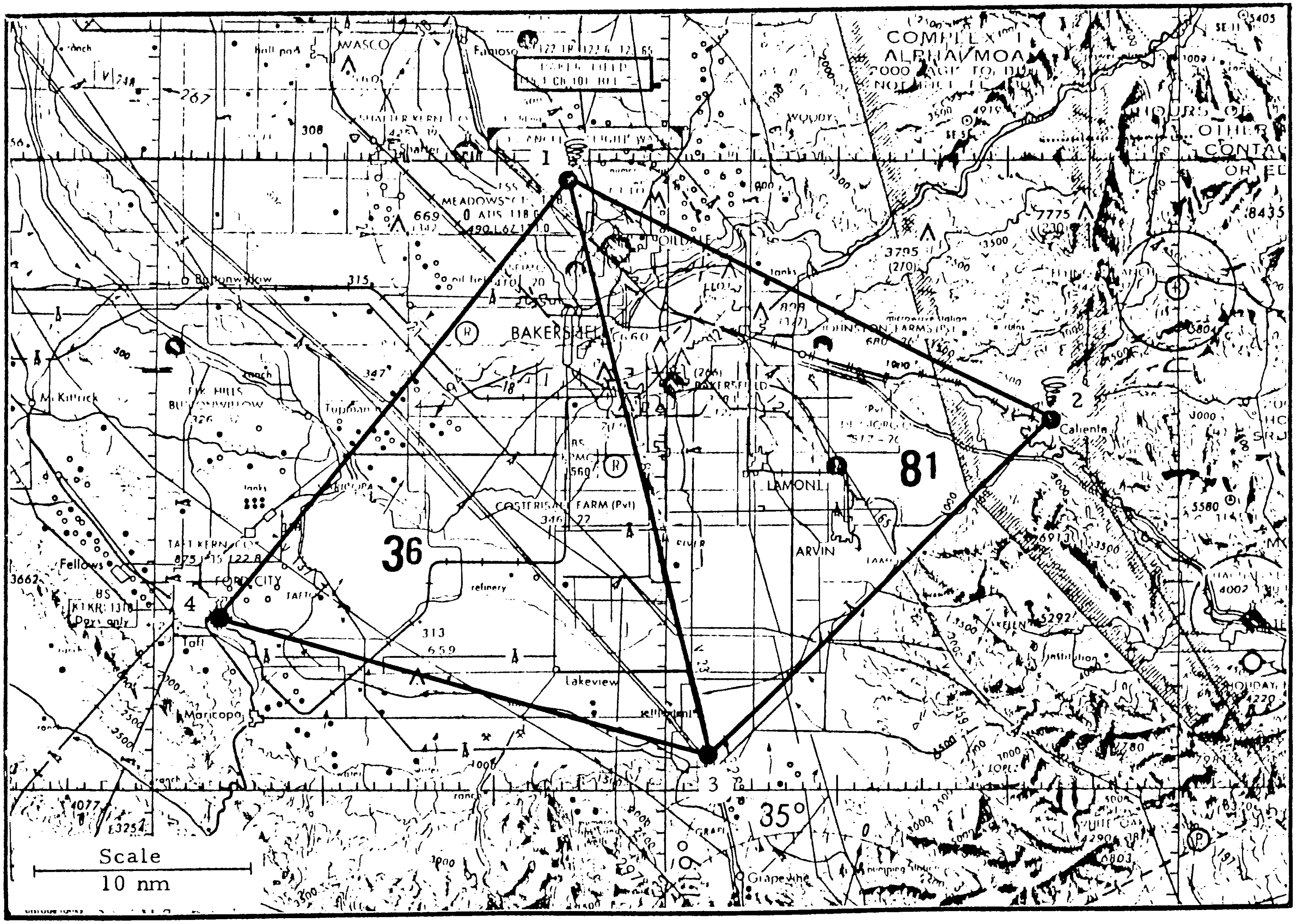
Table 3.1.3

MAXIMUM HOURLY CONCENTRATIONS
SEPTEMBER 5, 1979

Parameter	Location	Maximum Value (ppm)
SO_2	Bakersfield	.05
CO	Bakersfield	2
CO	Visalia	2
NO_x	Stockton	.27
SO_2	Arvin (RI)	.01
SO_2	Lost Hills (RI)	.01
NO_x	Arvin (RI)	.04
NO_x	Lost Hills (RI)	.04
NO_x	Reedley (RI)	.01

Aircraft Sampling

In conjunction with a tracer release from Oildale on the morning of the 5th, two aircraft sampling missions were flown; one on the afternoon (1608-1918 PDT) of the 5th, and again on the morning of the 6th (0733-1101 PDT). The southern region of the San Joaquin Valley was sampled on the afternoon flight. This flight included horizontal sampling within the mixing layer on both the west and east sides of the valley and vertical sampling in the Bakersfield area and over Caliente. The flight on the following morning was designed primarily to measure the dispersion of tracer material in the Tehachapi and Walker Passes and along the east side of the Sierras. Spirals were flown near Oildale, over Caliente and Tehachapi in Tehachapi Pass, over Mojave on the desert plateau on the east side of the mountains, and over Lake Isabella in Walker Pass. Figure 3.1.9 shows the sampling pattern for the afternoon flight on September 5. General pollutant characteristics observed on various segments of the pattern are summarized in Table 3.1.4. Aircraft soundings made during the flight are given in Figures 3.1.10 to 3.1.12.



SAMPLING ROUTES 5 SEPTEMBER 1979

Figure 3.1.9

Table 3.1.4

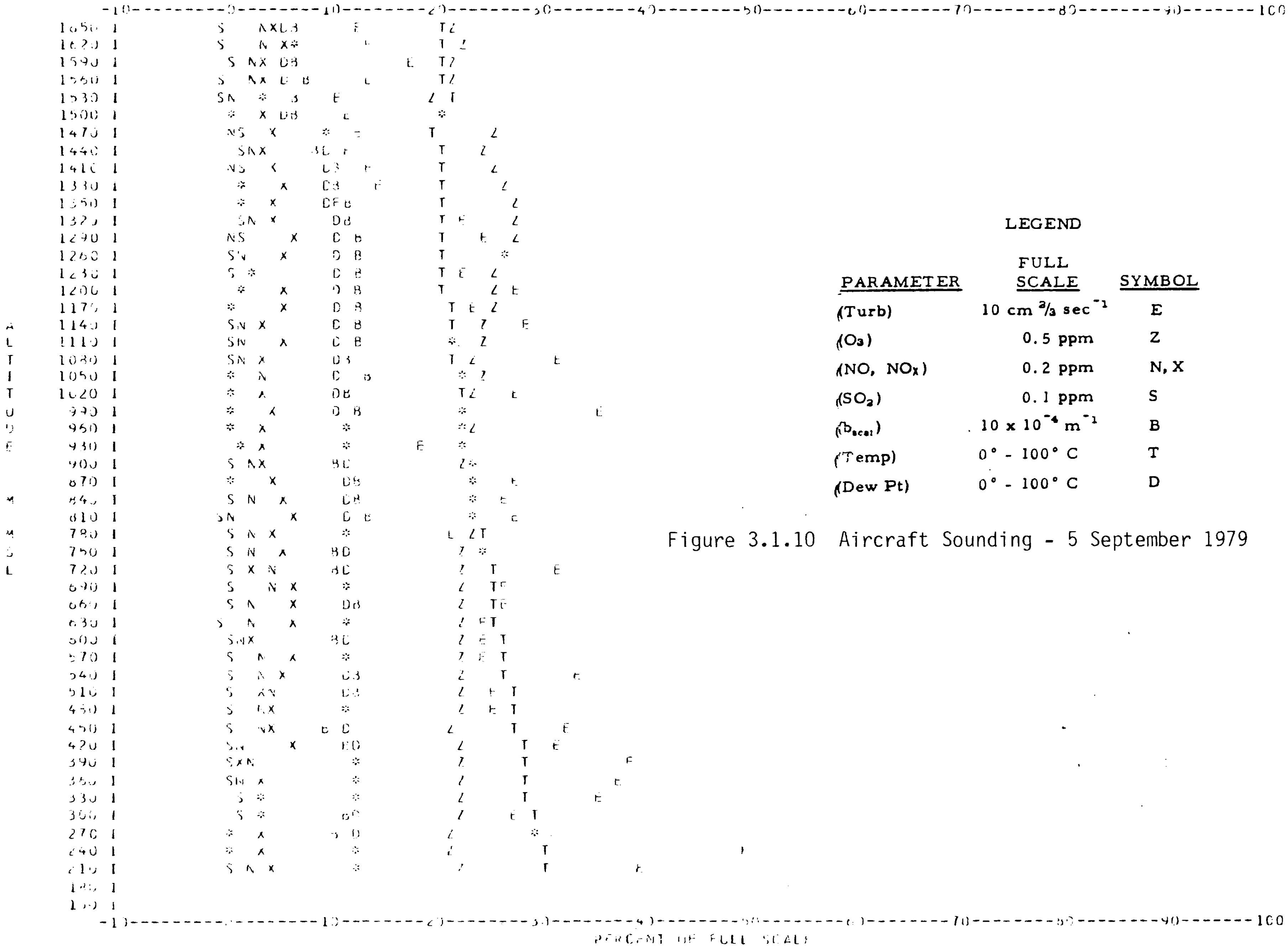
AIR QUALITY MEASUREMENTS CARB SAN JOAQUIN VALLEY PROJECT
SEPTEMBER 5, 1979 SAMPLING

		O_3		b_{scat}		SO_2		NO_x		NO	
Start Time (PDT)	Location (Point)	Mean (ppb)	Max (ppb)	Mean ($x10^{-6}m^{-1}$)	Max	Mean (ppb)	Max (ppb)	Mean (ppb)	Max (ppb)	Mean (ppb)	Max (ppb)
1605	1	110	141	85	178	0	3	7	23	3	17
1647	1-2	153	232	178	354	25	56	16	47	4	15
1704	2	147	200	141	280	1	4	10	22	3	17
1726	2-3	168	194	171	262	3	7	13	23	3	13
1742	3-1	127	199	129	274	3	28	12	40	3	17
1801	1-4	111	126	107	240	1	12	7	18	1	16
1818	4-3	113	121	1	138	0	1	7	17	1	12
1835	3-1	123	181	131	234	3	28	12	54	0	8
1854	1	108	132	102	364	-1	1	6	19	0	8

19-APR-80 11:18:31 PAGE 5

DATE: 9/ 5/79
CARTRIDGE/PASS: 7027 1
TIME: 16: 5:27 TO 16:24:53

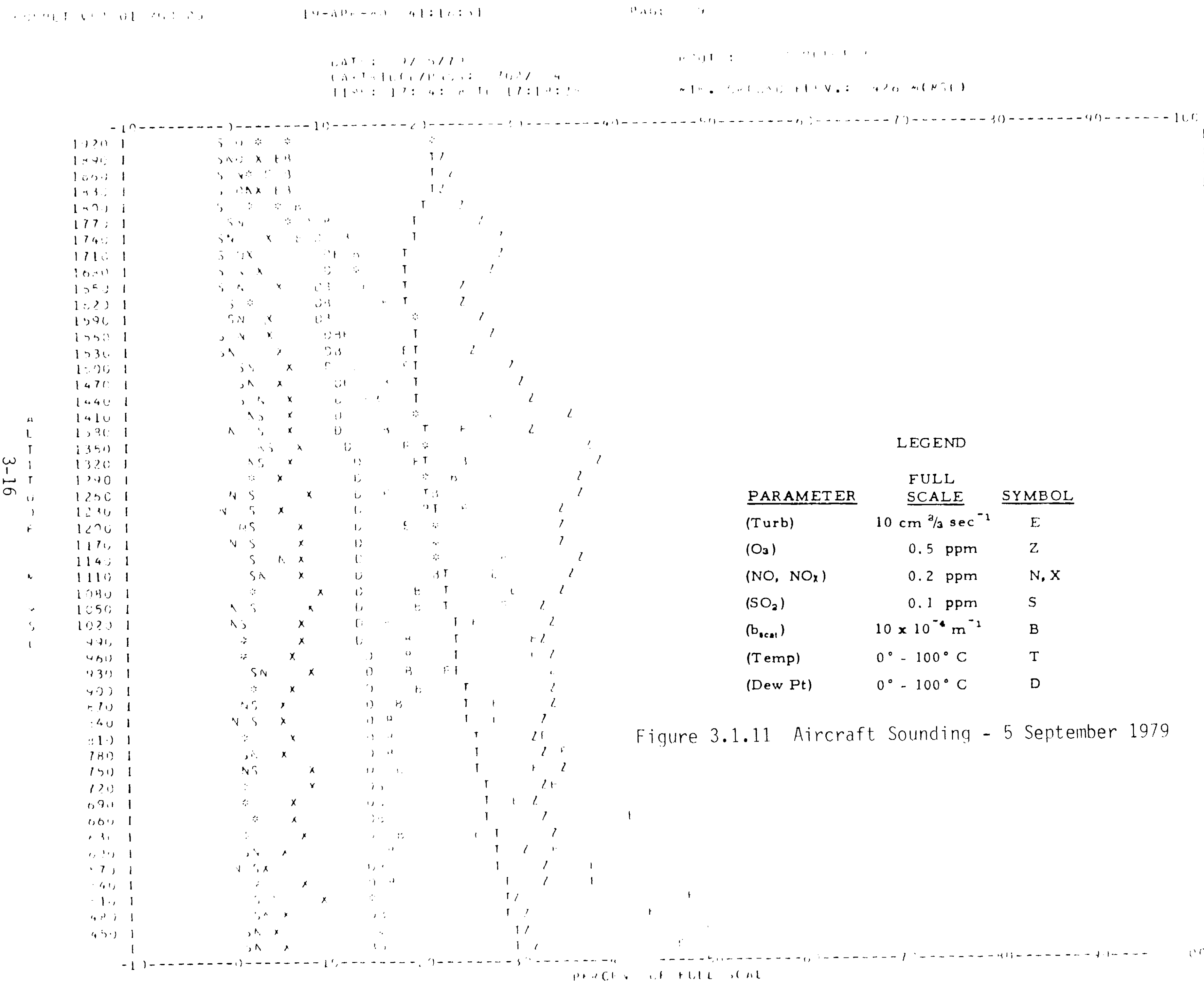
ROUTE: RIVER POINT 1
MIN. GROUND ELEV.: 152 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec $^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_X)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.10 Aircraft Sounding - 5 September 1979



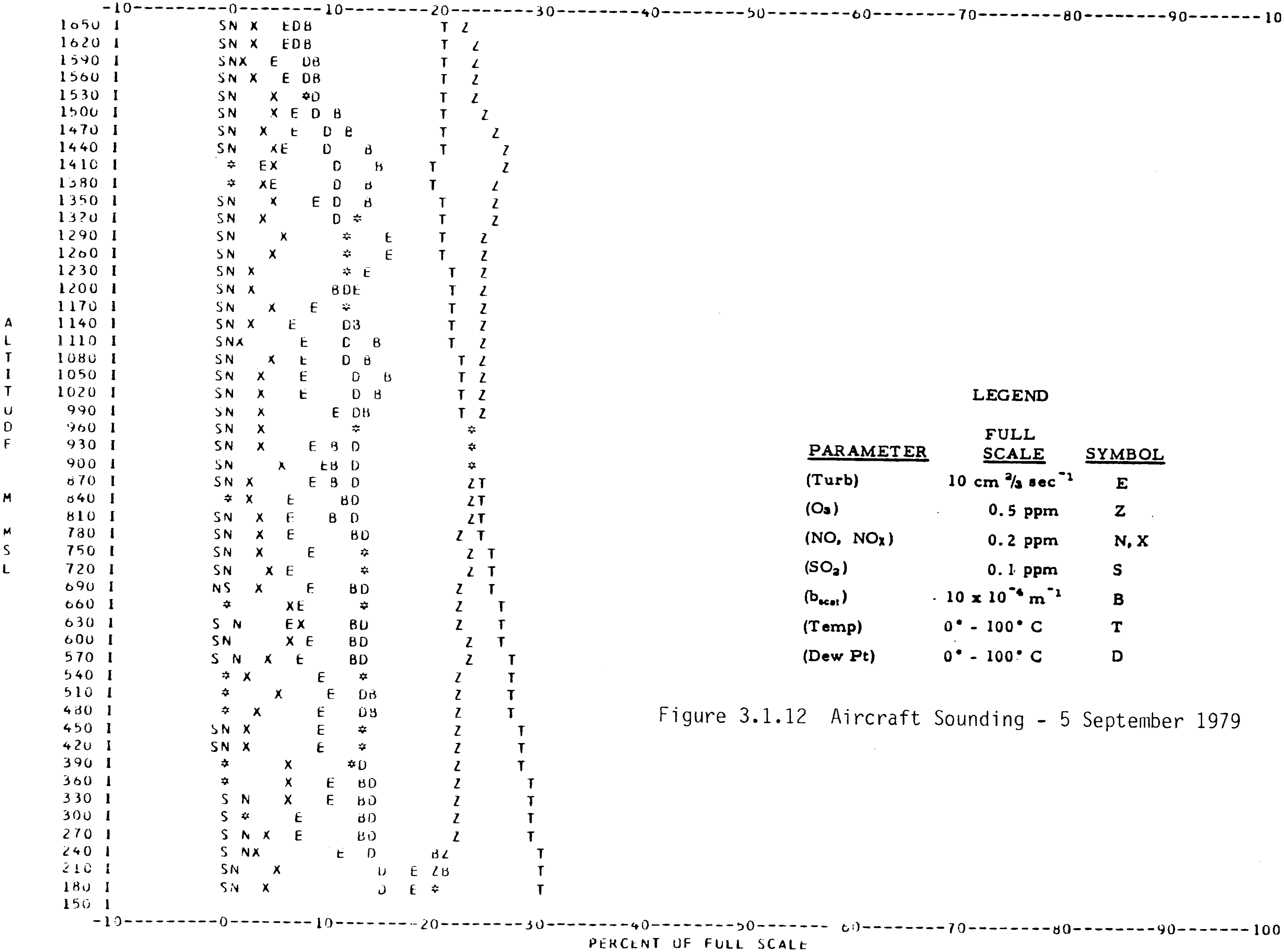
LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec^{-1}	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.11 Aircraft Sounding - 5 September 1979

DATE: 9/ 5/79
CARTRIDGE/PASS: 702/ 10
TIME: 18:53:50 TO 19: 6:36

ROUTE: OVER POINT 1
MIN. GROUND ELEV.: 152 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3}\ sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	$10 \times 10^{-4}\ m^{-1}$	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.12 Aircraft Sounding - 5 September 1979

The traverse from the Bakersfield VOR to Caliente (1647 PDT) passed over the oil fields east of Bakersfield and through the urban plume. Within the urban plume, which was centered approximately 20 nm southeast of the VOR (Point 1), ozone measurements exceeded .23 ppm. Low concentrations of SO_2 and NO_x were also present. Ozone levels as high as .20 ppm were measured over Caliente, with a maximum at 4300 ft-msl. On the east-west traverse from Caliente to the southern part of the valley (Point 3), the air quality improved considerably as would be expected from the existing northwest winds. Relatively good air quality measured on subsequent traverses in the west valley confirmed general air movement toward the southeast. Ozone measurements were relatively constant, averaging about .11 ppm, on the west side with only low concentrations of oxides of nitrogen and SO_2 observed. Visibility was significantly improved during this part of the flight.

On the two duplicate traverses from the I-5 and Highway 99 intersection (Point 3), roughly following 99, an ozone plume was intersected approximately 7 nm wide, centered about 9 nm north from the intersection. Concentrations of .20 ppm were measured within the plume. Examination of the tracer results confirmed that this plume had originated from the release area earlier that day.

Figure 3.1.10 shows the sounding made near Bakersfield at 1605 PDT. A well-mixed layer exists to about 930 m (msl), characterized by uniform ozone concentrations of about .11 ppm. A higher ozone layer (.14 ppm) existed within a stable layer centered at about 1320 m (msl). NO_x and SO_2 concentrations were relatively low throughout the sounding.

Figure 3.1.11 gives the sounding obtained over Caliente at 1704 PDT. The mixed layer over Caliente was somewhat deeper than at Bakersfield and included significantly higher levels of ozone (to .19 ppm). Transport from the Bakersfield area was indicated by the high ozone levels coupled with the northwest flow.

The sounding in Figure 3.1.12 was made near Bakersfield at 1853 PDT. There was little important change in the ozone profiles during the three hours since the data in Figure 3.1.10 were obtained.

Figure 3.1.13 shows the aircraft sampling route followed on the morning of September 6. Table 3.1.5 summarizes the pollutant characteristics found during the sampling flight. Figures 3.1.14 to 3.1.18 show the detailed soundings made during the morning flight.

Figure 3.1.14 (0735 PDT) shows the large build-up of pollutants in the low layers which occurs during the night. High values of SO_2 and NO_x were observed in a 300 m layer near the surface. Ozone concentrations were not obtained during this sounding.

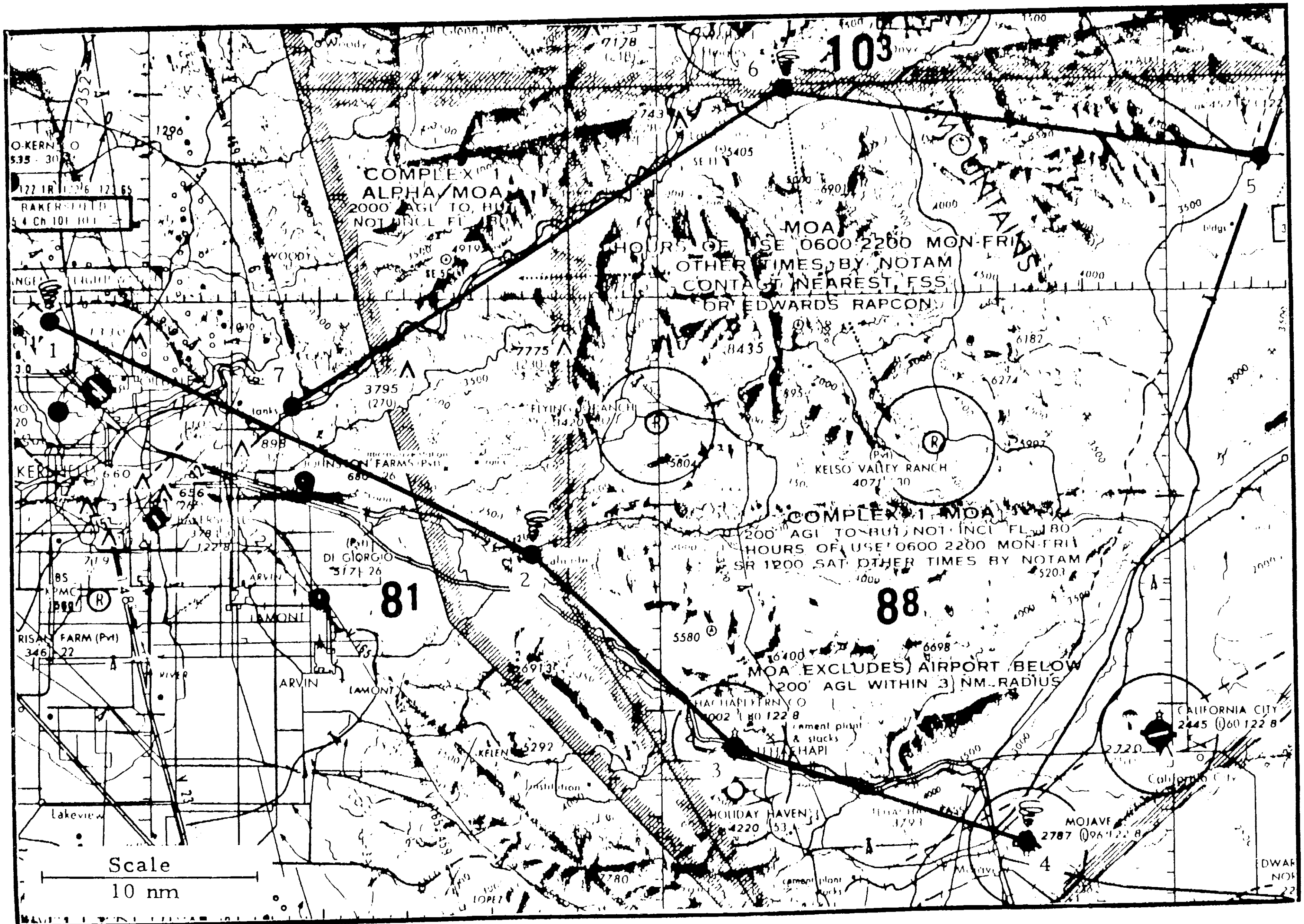
The sounding at 0828 PDT (Figure 3.1.15) was made over Caliente. A low level mixed layer is apparent from the high turbulence values in the lowest 400 m. Ozone values were relatively high (.12 ppm) above the mixed layer, indicating considerable carry-over from the previous day.

Figure 3.1.16 was made at Mojave at 0909 PDT. Reduced ozone values are apparent in the low layers but a pronounced ozone peak (.15 ppm) existed at 1710 m (msl). From the trajectories and the previous days sampling it is probable that this ozone layer originated in the San Joaquin Valley.

Figure 3.1.17 was obtained over Lake Isabella at 1001 PDT. The mixed layer extended to about 400 m above ground level. A significant ozone layer existed aloft with a base at about 1600 m (msl).

Figure 3.1.18 was made near Bakersfield at 1042 PDT, about 3 hours after Figure 3.1.14. The mixed layer had increased to about 600 m (above ground level). SO_2 and NO_x values were considerably decreased. A significant and deep ozone layer (.14 ppm) existed above the mixed layer.

Ozone concentrations during horizontal traverses were relatively constant from the valley into the passes, averaging .10-.11 ppm but dropped slightly east of the mountains.



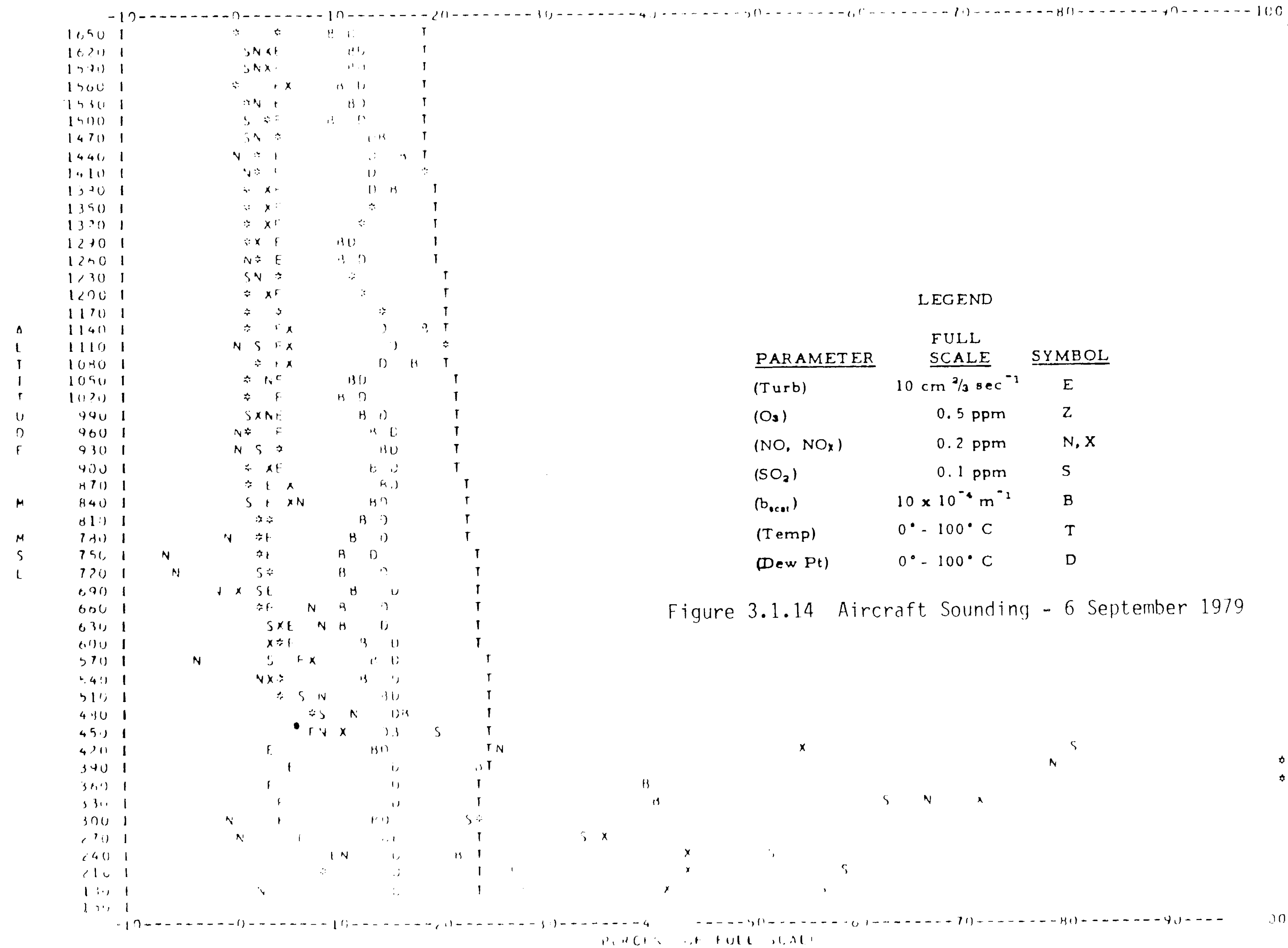
SAMPLING ROUTES 6 SEPTEMBER 1979

Figure 3.1.13

Table 3.1.5

AIR QUALITY MEASUREMENTS CARB SAN JOAQUIN VALLEY PROJECT
SEPTEMBER 6, 1979 SAMPLING

Start Time (PDT)	Location (Point)	O_3 Mean (ppb)	O_3 Max (ppb)	b_{scat} Mean ($\times 10^{-6} m^{-1}$)	b_{scat} Max ($\times 10^{-6} m^{-1}$)	SO_2 Mean (ppb)	SO_2 Max (ppb)	NO_x Mean (ppb)	NO_x Max (ppb)	NO Mean (ppb)	NO Max (ppb)
0736	1	-	-	112	876	8	174	17	290	10	255
0811	1-2	109	134	133	206	3	16	7	20	2	11
0828	2	97	126	102	218	2	4	5	14	2	8
0850	2-3	112	117	103	148	1	1	4	10	2	8
0858	3-4	105	119	78	154	2	36	5	33	2	16
0909	4	93	147	67	150	2	17	5	27	2	11
0939	5-6	97	109	60	102	1	1	4	11	1	9
1002	6	89	118	68	180	1	2	3	12	2	15
1020	6-7	99	121	96	178	1	2	6	18	1	7
1043	1	107	143	103	256	1	9	9	61	3	19

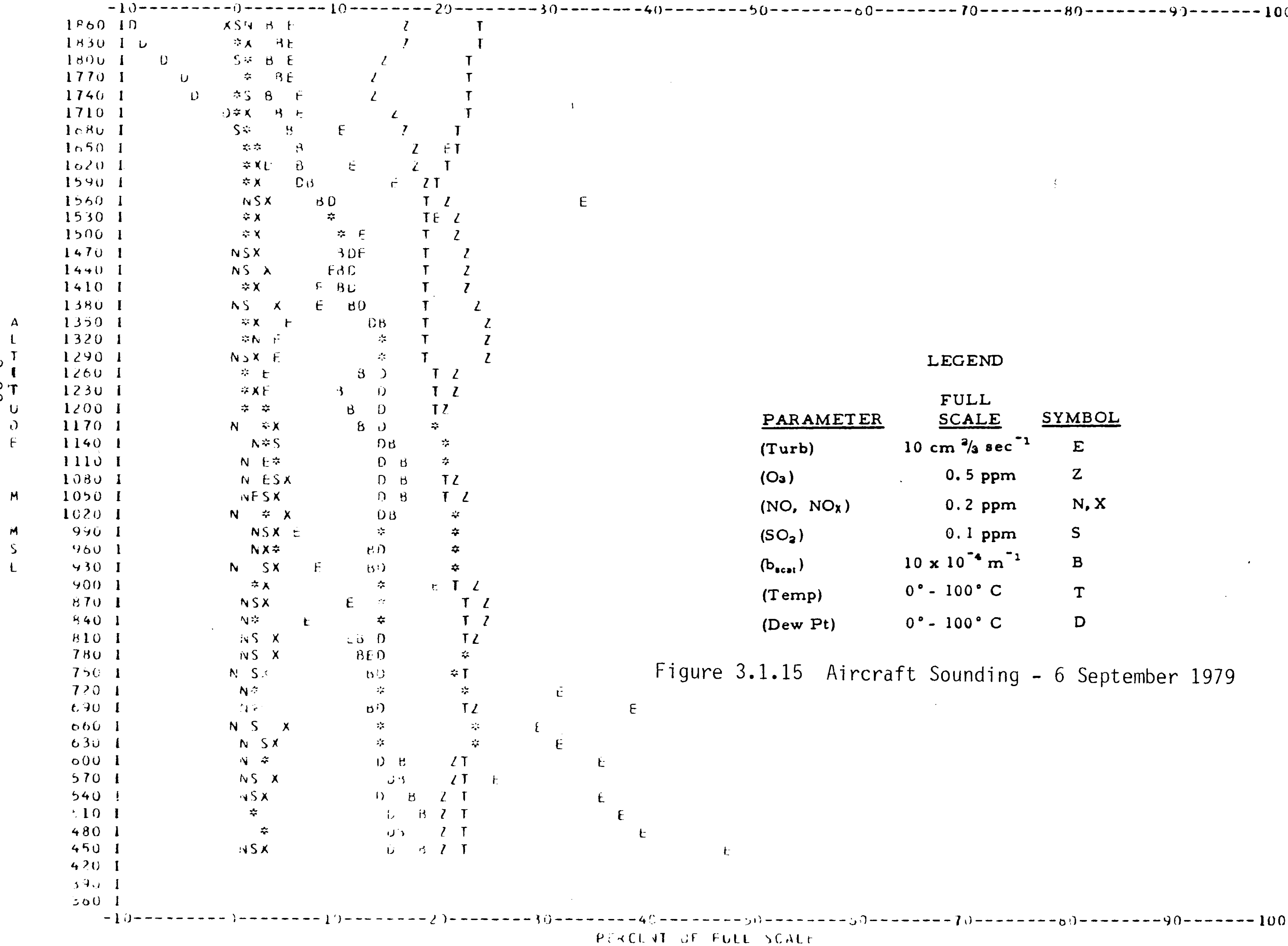


LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3} sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	$10 \times 10^{-4}\ m^{-1}$	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.14 Aircraft Sounding - 6 September 1979

DATE: 9/ 6/79   ROUTE: OVER POINT 2
CARTRIDGE/PASS: 763/ 4
TIME: 8:28:11 TO 8:43:32   MIN. GROUND ELEV.: 365 M(MSL)



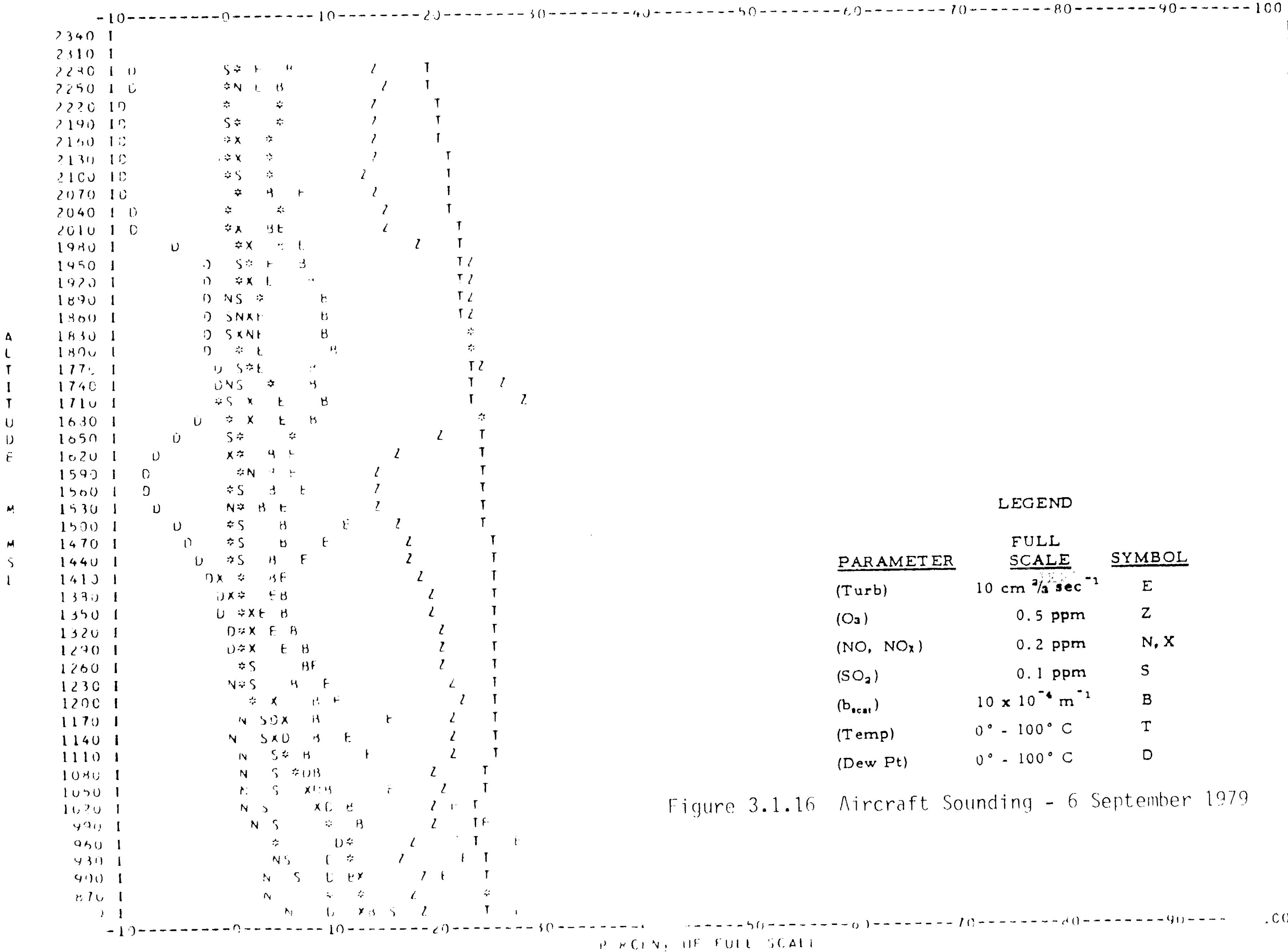
LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec $^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_X)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.15 Aircraft Sounding - 6 September 1979

CDEPLT VER 01 MOD 03   19-APR-80 42:15:40   PAGE 15

DATE: 9/ 6/79   ROUTE: SV-2 POINT 4
CARTRIDGE/PASS: 7037 7
TIME: 9: 9:25 TO 9:20:15   MIN. GROUND ELEV.: 349 M(MSL)



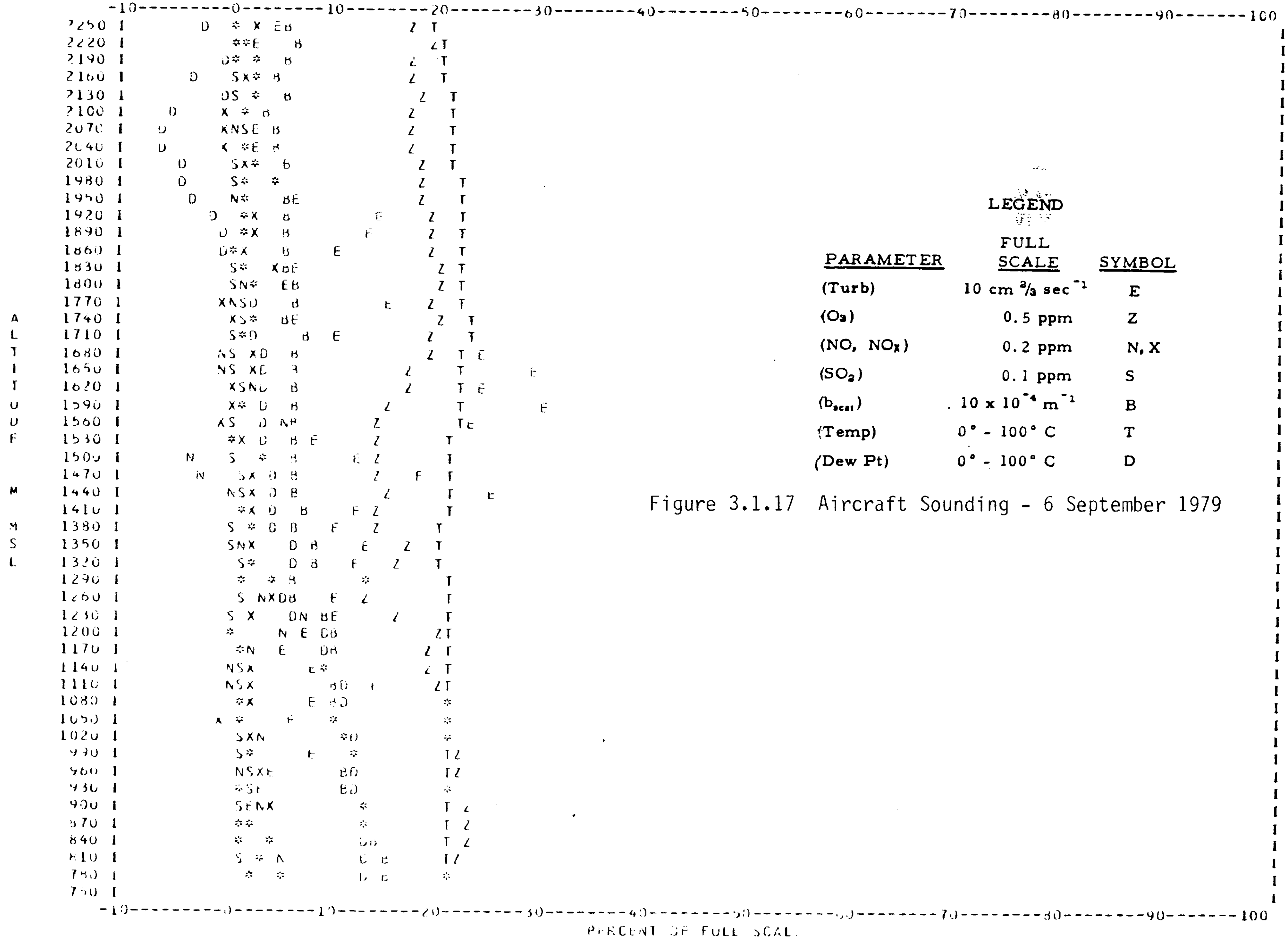
LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec $^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.16 Aircraft Sounding - 6 September 1979

COFPLT VER 01 MOD 03　　19-APR-80　42:15:40　　PAGE 17

DATE: 9/ 6/79　　ROUTE: OVER POINT 6
CARTRIDGE/PASS: 703/ 9
TIME: 10: 1:36 TO 10:17:11　　MIN. GROUND ELEV.: 762 M(MSL)



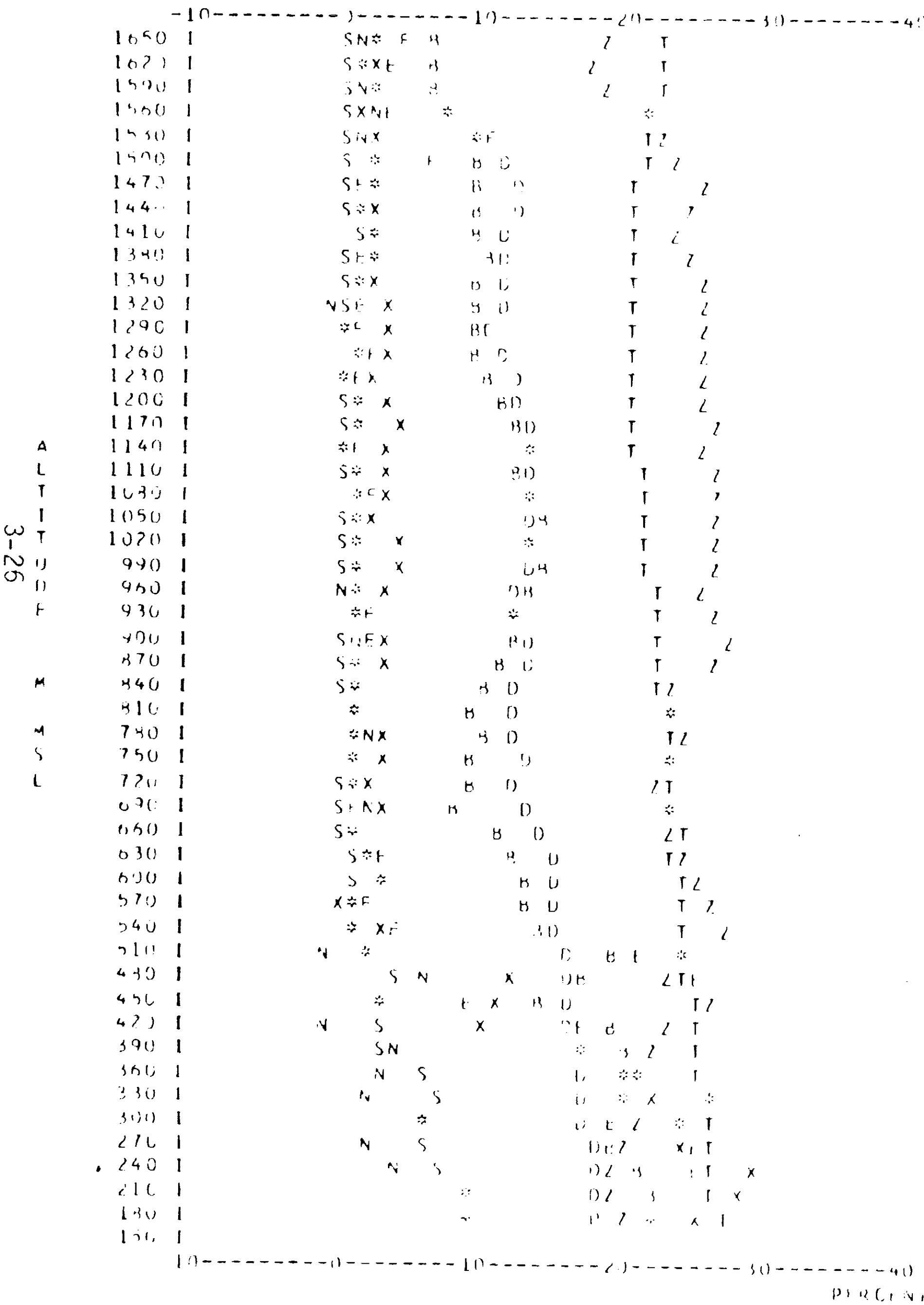
LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2}/_{3}$ sec^{-1}	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.17 Aircraft Sounding - 6 September 1979

DATE: 9/ 6/79
CARTRIDGE/PASS: 7037 11
TIME: 10:42:33 TO 10:57:)

ROUTE: [illegible]
MIN. GROUND ELEV.: 152 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2}/_{3}$ sec^{-1}	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.1.18 Aircraft Sounding - 6 September 1979

3.1.3 Tracer Test 1

Release Location: Oildale, Kern County

Time and Date: 0700-1200 PDT, 9/5/79

Release Amount: 107 lbs SF6/hr

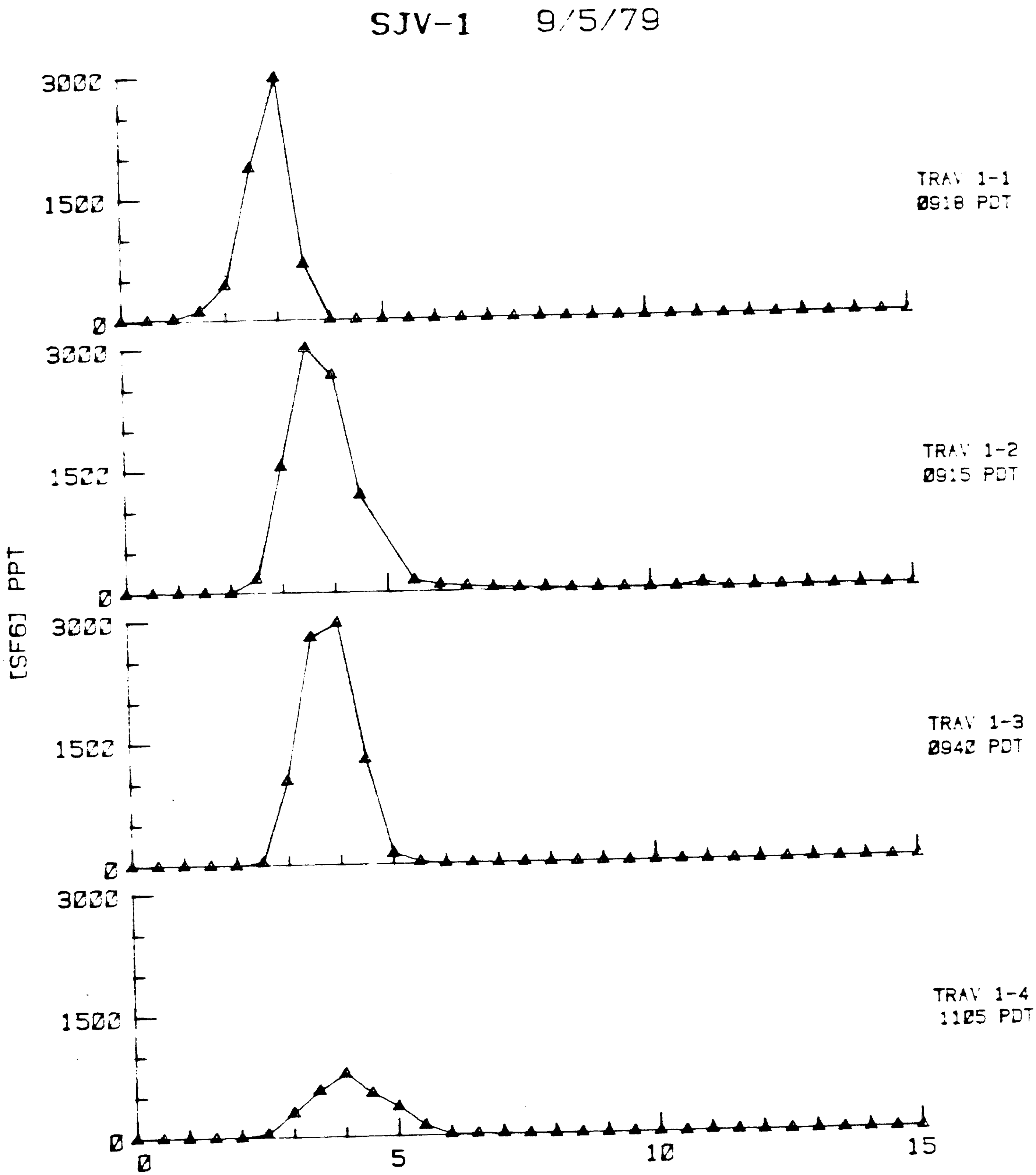
Release conducted during end of southeasterly drainage winds and beginning of northwesterly afternoon upslope flow.

Initial Transport towards the northwest

During Automobile Traverses 1-1, 1-2, and 1-3, a distinct tracer plume was detected northwest of the release sites along Hwy's 65 and 99. The plumes detected along Hwy 65 are shown in Figure 3.1.19. The spread of the tracer plumes shown in this Figure corresponded to that predicted by the Gaussian plume model during slightly unstable conditions (Pasquill-Gifford Stability Class C). Assuming that the detected plume contained 100% of the released tracer, it was possible to estimate that the vertical dispersion of the tracer corresponded to neutral atmospheric conditions (Stability Class D). Before the onset of northwesterly winds at about 1000-1100 PDT, the tracer was detected as far northwest as Shafter, about 15 miles from the release site.

Transport by afternoon upslope winds

By about 1000-1100 PDT, the afternoon northwesterly wind condition had begun to develop around Bakersfield. The tracer was thus transported back toward the east. That part of the tracer that had originally been transported westward was spread over a wide area during the complex flow transition from dowslope to upslope flow. Most of the transition can be characterized by light and variable winds . It is therefore difficult, at best, to determine any sort of plume trajectory during a wind reversal. As indicated during previous tests, a tracer or pollutant plume tends to become well-mixed laterally over a wide area during a wind reversal. During this experiment, the tracer was detected all the way from northeast of the release site to directly south of the release site after the onset of the afternoon upslope flow. Tracer concentrations over this zone were roughly the same except for points east of



TRAVERSE ROUTE: NORTH ON 65

RELEASE LOCATION: 535 # SF6 AT OILDALE
RELEASE TIME: 0700-1200 PDT, 9/5/79

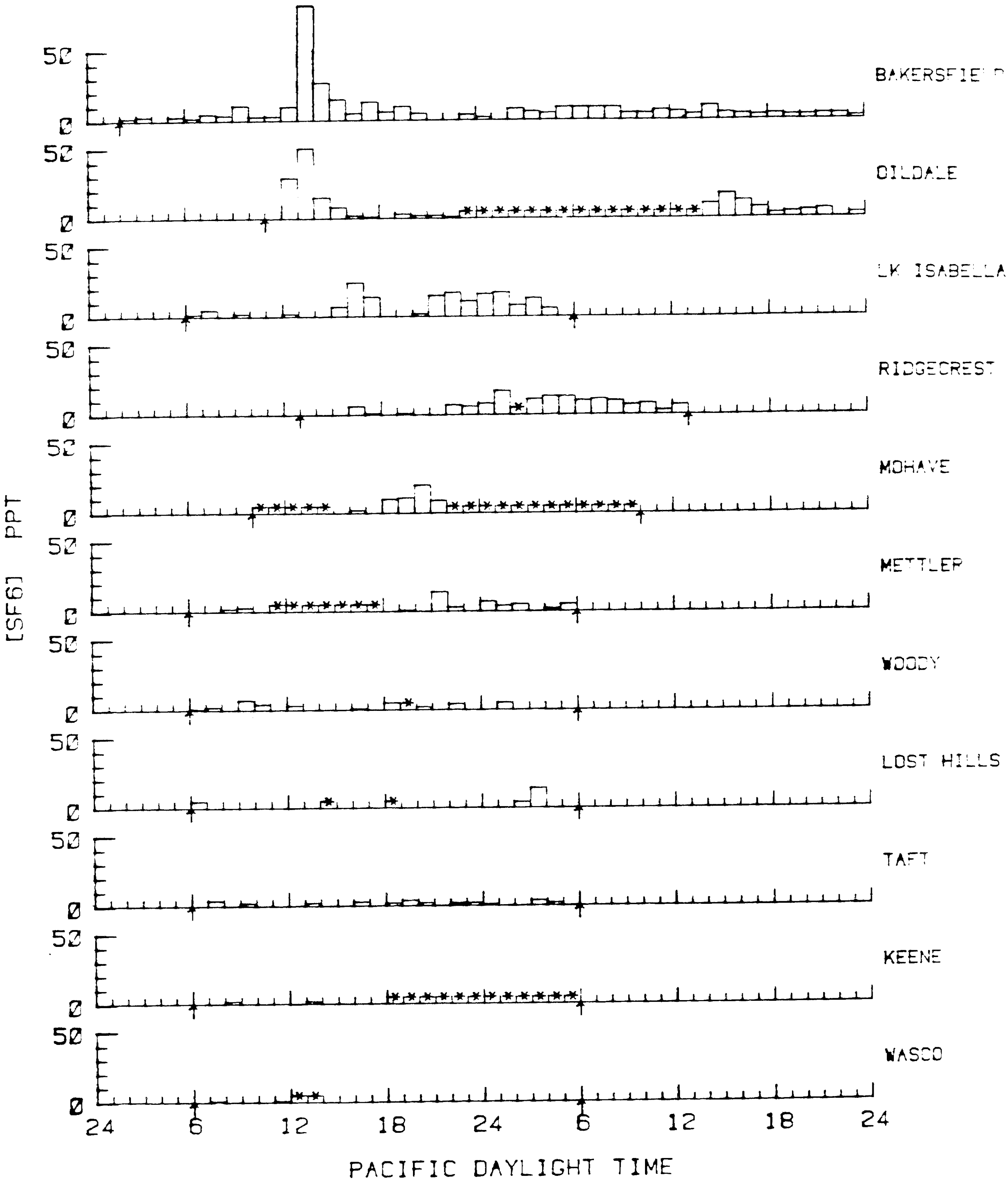
Figure 3.1.19

the source. Locations east of the release site were directly impacted by the tracer which was released for at least an hour after the onset of the afternoon winds.

The hourly-averaged sampler data (Figures 3.1.20 and 3.1.21) clearly indicates the tracer was spread over a wide zone during the wind reversal. The similar tracer concentrations detected at Oildale and Bakersfield show that the tracer had tagged the entire air mass overlying Oildale and Bakersfield. The tracer movement throughout the afternoon was thus indicative of the movement expected of pollutants emitted anywhere within the Oildale-Bakersfield area. The tracer impacted Lake Isabella to the northeast and Mettler to the south. As shown in Figure 3.1.22, automobike traverses indicated that a most of the area between these two extremes was also impacted. As mentioned previously, the highest concentrations were detected directly east of the release site (Jct Hwy's 58 & 184). But as shown in Figure 3.1.22, Traverses 1-7 and 1-11 detected a significant amount of SF6 southeast of Bakersfield. During Traverse 1-14, conducted after the end of the afternoon upslope flow, the area south and east of Bakersfield was found to be well-mixed at an average concentration of 14+/-4 PPT SF6. Based upon a mixing height of 3-4000 ft at Bakersfield, the amount of SF6 within the area enclosed by this traverse was about 15% of that originally released. The rest of the tracer was apparently carried up and over the mountain slopes east of Bakersfield into the Mojave Desert.

This was indeed the case, as shown in Figure 3.1.23. This figure details a series of traverses conducted along Hwy 14 in the Mojave Desert. The tracer was first detected in the desert at about 1800 PDT. A well-defined plume was detected at about this time in the vicinity of Red Rock Canyon, directly east of Bakersfield. This canyon is located about 60 miles east of the release site, which corresponds to a mean transport speed (based on the end of the release) of about 10 miles/hr. By about 2000 PDT, the tracer was detected over the entire length of Hwy 14 from Lancaster to the Jct of Hwy 14 with Hwy 395, a distance of about 75 miles. The well-defined plume near Red Rock Canyon was probably that part of the tracer released after the start of the upslope winds while the more uniform concentrations detected later were due to the tracer originally transported by the nighttime and morning drainage winds and spread over a wide area during the transition to the upslope flow. An hourly-averaged sampler located at Ridgcrest, near the China Lake Naval Weapons Center, first

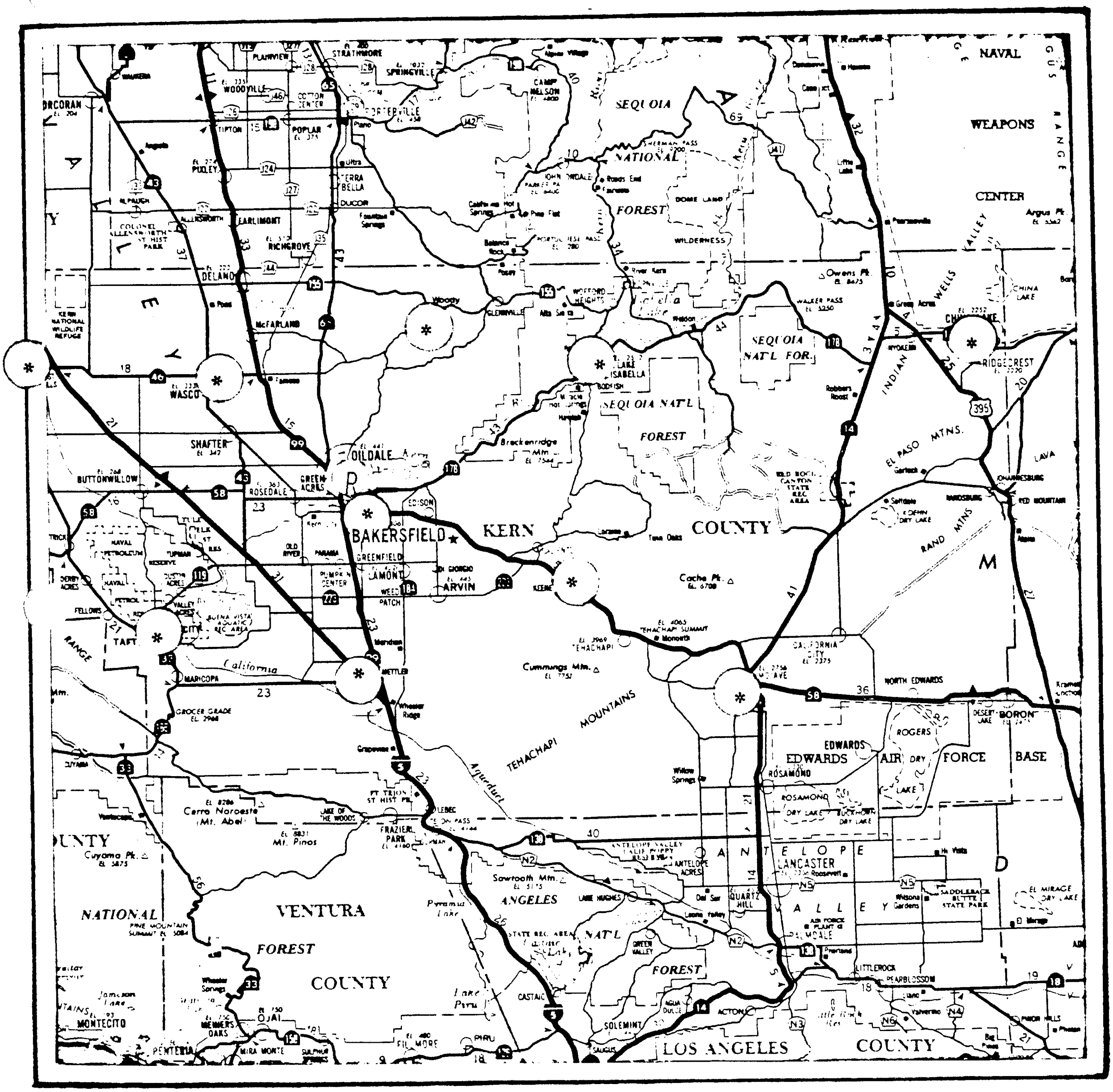
SJV-1 9/5/79 - 9/6/79



RELEASE LOCATION: 535 # SF6 AT OILDALE
RELEASE TIME: 0700-1200 PDT, 9/5/79

* INDICATES MISSING DATA
ARROWS INDICATE BOUNDS OF SAMPLING PERIOD
LOCATIONS ORDERED BY RELATIVE IMPACT

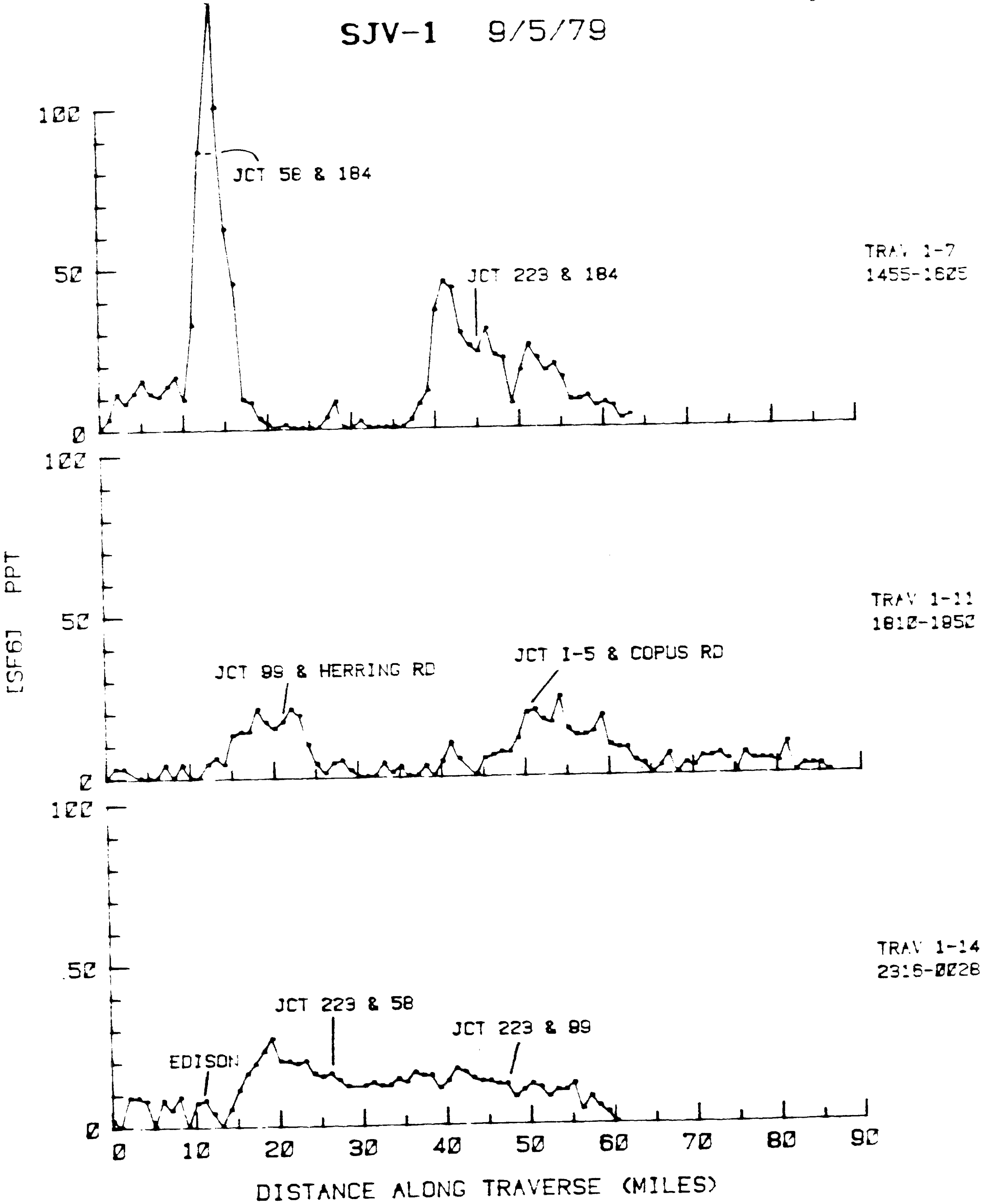
Figure 3.1.20



INDICATES SAMPLER LOCATIONS

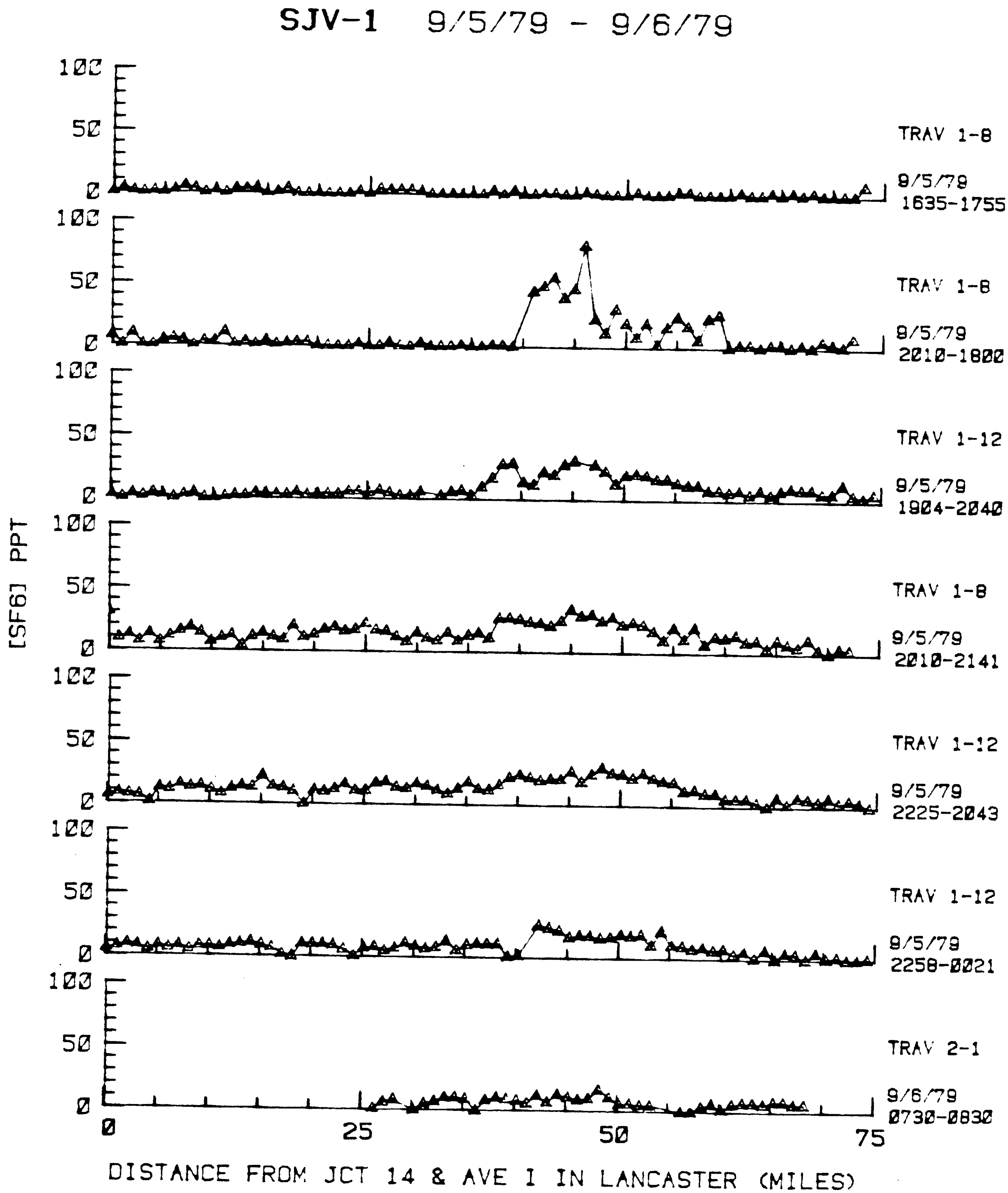
R IS THE RELEASE SITE

Figure 3.1.21



RELEASE LOCATION: 535 # SF6 AT OILDALE
RELEASE TIME: 0700-1200 PDT, 9/5/79

Figure 3.1.22



TRAVERSE ROUTE: NORTH ON 14

RELEASE LOCATION: 535 # SF6 AT OILDALE
RELEASE TIME: 0700-1200 PDT, 9/5/79

Figure 3.1.23

detected a significant amount of SF_6 at about 2200 PDT. This timing agrees well with the arrival of SF_6 along Hwy 14.

The impact of the lower San Joaquin Valley upon the Mojave Desert

As indicated above, the tracer released at Oildale was found to lead to transport up and over the Tehachapi Mountains and into the Mojave Desert. An examination of either traverse or hourly-averaged concentrations both within the San Joaquin Valley and the Mojave Desert indicates that the tracer was diluted by a factor of between 2 and 3 during passage over the Tehachapi Mountains. This dilution ratio was verified for a number of conserved pollutants by J.R.Ouimette (see Reible, et al, Appendix G). Thus the southern San Joaquin Valley can have a significant impact upon the Mojave Desert. Furthermore, in order to account for 100% of the tracer released, the tracer must have been well-mixed over about the same height on both the western and eastern slopes of the mountains. This suggests that horizontal dispersion of the tracer over the mountains must have accounted for the bulk of the decrease in concentration. Thus as the source areas grow in size within the San Joaquin Valley and the effect of horizontal dispersion is minimized, the relative impact of the San Joaquin Valley upon the northern Mojave Desert will increase.

Even at the present time, however, the impact of the San Joaquin Valley on air quality in the northern Mojave Desert is significant. As shown in Figure 3.1.24, the scattering of light due to particles which is inversely proportional to visibility, rapidly increases near nightfall at China LAke. The broken lines show the particle scattering coefficient within one standard deviation of the mean for September 1978 and 1979. The solid line shows the particle scattering coefficient on the day of this test. Note that the arrival of SF_6,shown in the bottom figure corresponds to the arrival of visibility degrading aerosol. Clearly, the southern San Joaquin Valley is the source of the degradation in visibility typically experienced at China Lake during the summer nighttime hours. Typically the visibility drops from 100 miles or more during mid-afternoon to about 30-40 miles shortly after nightfall. Note that this estimate of the visibility degradation is based only upon the measured scattering coefficient due to particles and thus is not subject to many of the errors inherent in a direct estimate of visual range.

HOURLY AVERAGE SCATTERING DUE TO PARTICLES, b_{SP}, AT CHINA LAKE AND $[SF_6]$ AT RIDGECREST

9/5/79 - 9/6/79

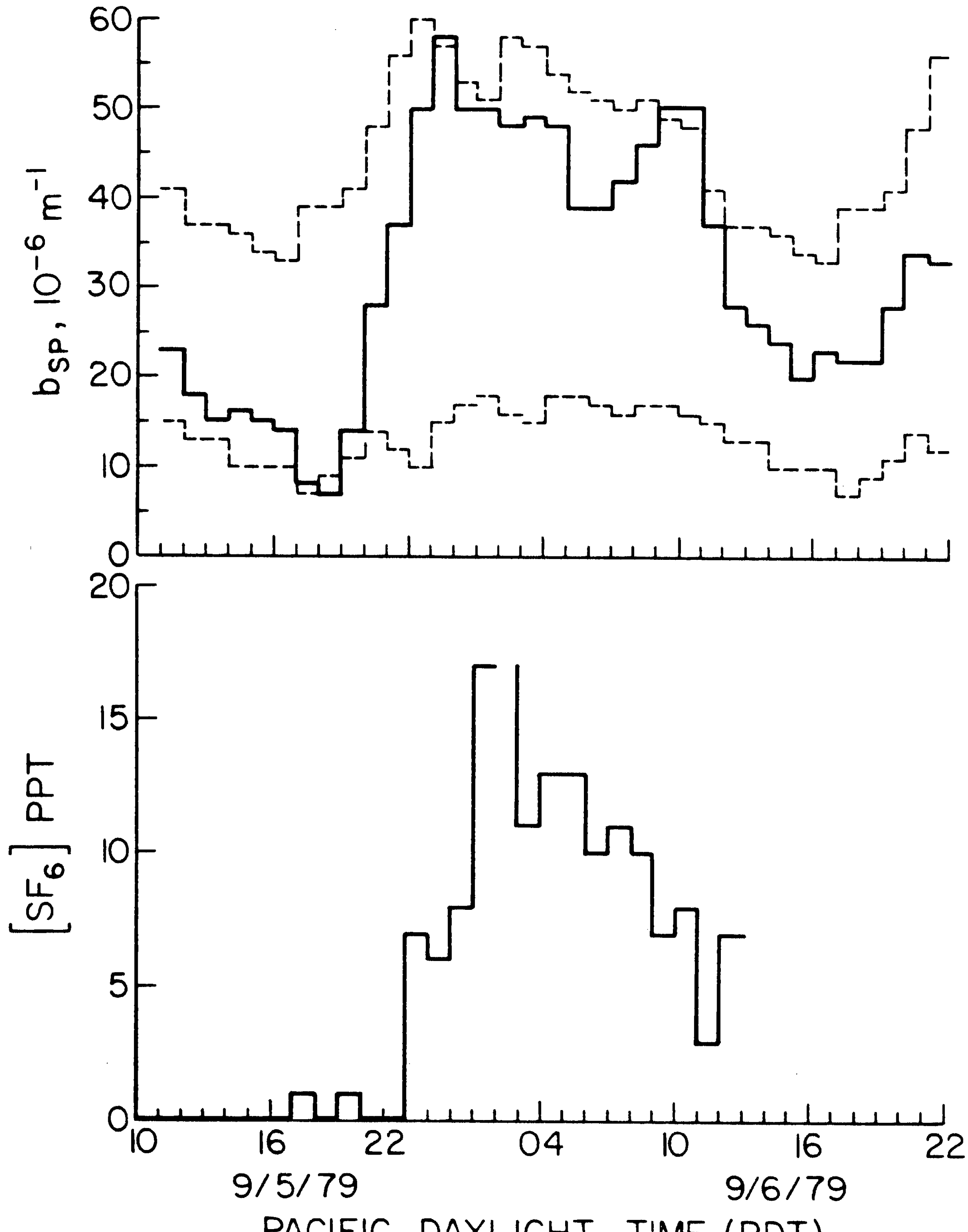
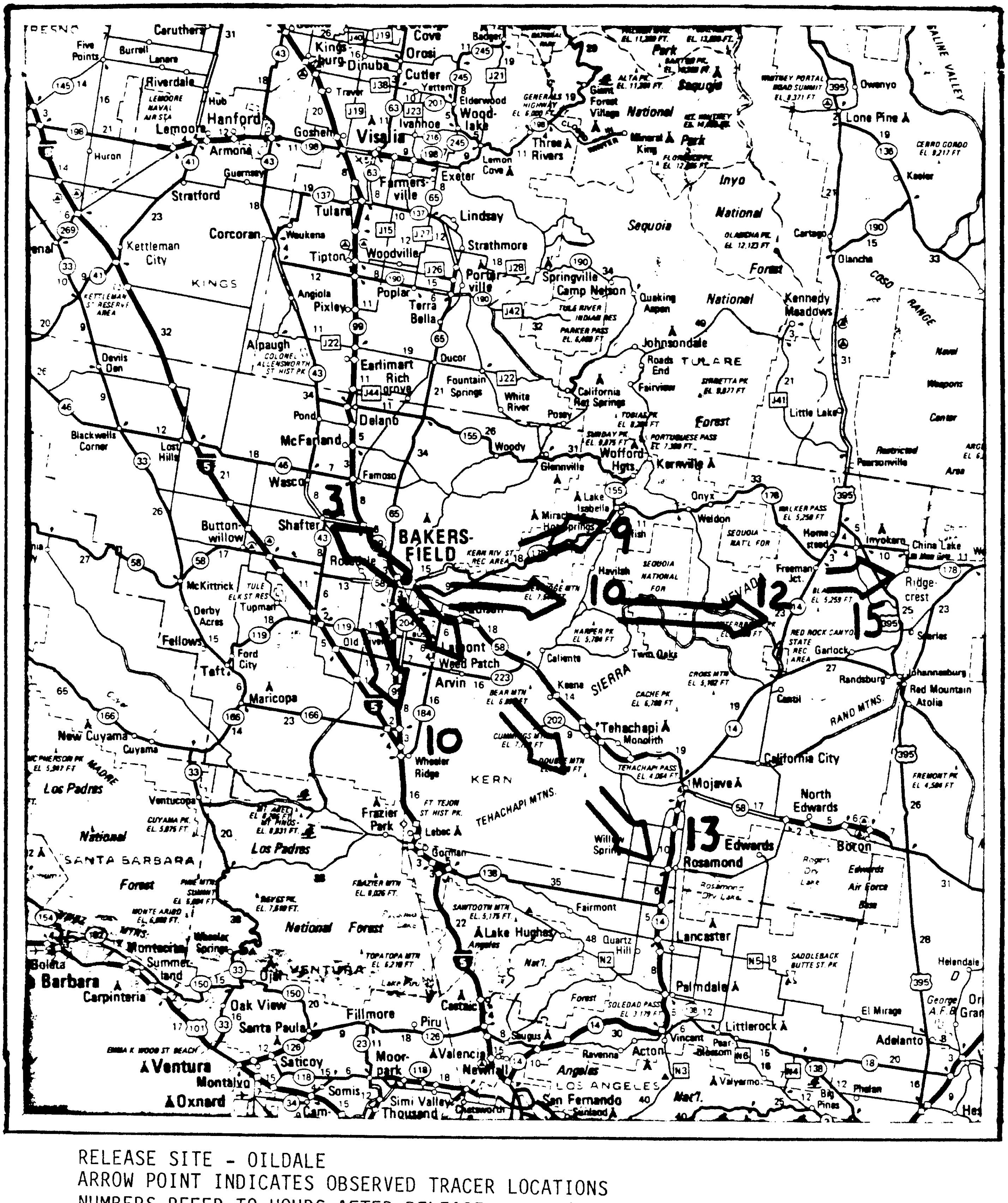


Figure 3.1.24

Summary

During this experiment, tracer was released during the transition from downslope to upslope flow at Oildale, in the southern San Joaquin Valley. The tracer was initially transported towards the northwest, but during the subsequent wind reversal, the tracer was transported to the northeast of the tracer release site to Lake Isabella, east to the Tehachapi Mountains and into the Mojave Desert, and south to Mettler. Initially, during the downslope flow, the concentration profiles downwind of the source were Gaussian in shape. The horizontal dispersion corresponded to that expected under slightly unstable atmospheric conditions while the vertical dispersion of the tracer corresponded to that expected under neutral atmospheric conditions. The tracer was spread rather uniformly over a wide zone during the wind reversal and thus the Gaussian plume model was no longer applicable. Since the tracer release continued after the onset of the afternoon upslope flow, points east of the release site also detected the impact of a direct, i.e. non-reversed, tracer plume.

An overview of the tracer transport path is shown in Figure 3.1.25. The impact of the tracer on the Mojave Desert coincided with the impact of visibility reducing aerosol particles at China Lake, thus indicating that the southern San Joaquin Valley was the source of the visibility degrading aerosol. Horizontal dispersion apparently led to pollutant and tracer concentrations a factor of about 2 or 3 lower in the Mojave Desert than in the southern San Joaquin Valley. The development of a less centralized source area within the San Joaquin Valley would thus be expected to lead to a larger relative impact on the Mojave Desert. Although not a part of this study, a tracer release was conducted in July of 1978 from the northern Los Angeles Basin, to determine its impact on the Mojave Desert. As shown in the figure, the impact of the Los Angeles Basin is somewhat south of the impact of the southern San Joaquin Valley. Both source areas, however, do impact the Mojave Desert, and this receptor area must be considered during the development of regulations concerning the source areas themselves.



RELEASE SITE - OILDALE
ARROW POINT INDICATES OBSERVED TRACER LOCATIONS
NUMBERS REFER TO HOURS AFTER RELEASE START (0700 PDT, 9/5/79)

Figure 3.1.25

3.2 Test 2 8-9 September 1979, Oildale Release (0200-0700 PDT)

3.2.1 Meteorology

General

The synoptic meteorology of the 8-9 September period was characterized by the presence of a trough at 500 mb offshore of California (Figure 3.2.1). As reflected in the 850 mb temperatures shown on Figure 2.2.1, only the northern half of the state was significantly impacted by the cooler air associated with the trough. The temperature aloft over Vandenberg shows well above normal temperatures for the 8th and 9th. At the surface, the weak weather system in northern California did not seriously affect conditions in the San Joaquin Valley but did allow cooler air to intrude which resulted in the maximum temperature at Bakersfield dropping from 105°F on the previous day to 92°F on the 8th. Skies remained generally clear throughout the period. Visibilities ranged from 15-30 miles in the Fresno and Bakersfield areas.

Transport Winds

The surface winds from Oildale during the morning of the tracer release are tabulated in Table 3.2.1. Winds were from the south to southwest at speeds of 1-2 m/s throughout the release. The surface winds continued from the southwest at 1-2 m/s until 1200 PDT when the flow shifted to westerly and wind speeds increased. The wind continued from the west for the remainder of the day at speeds ranging from 3-5 m/s.

The temporal variation of the winds aloft on the 8th can be examined from the time-height cross section of the pibal observations from Bakersfield (Figure 3.2.2). The flow, which had been northwesterly since the start of the tracer release, shifted to westerly below 600 m by 0500 PDT as the nocturnal jet dissipated. On the 0500 and 0700 PDT observations, the flow was southerly in the first 100 m above the ground. By 1100 PDT, the flow below 800 m was generally out of the northwest and remained so through the 1500 PDT observation. Thereafter the winds below 400 m, although principally from the west, contained a southerly component. By 2100 PDT the flow in the first 100 m had again shifted to southerly.

SATURDAY, SEPTEMBER 8, 19

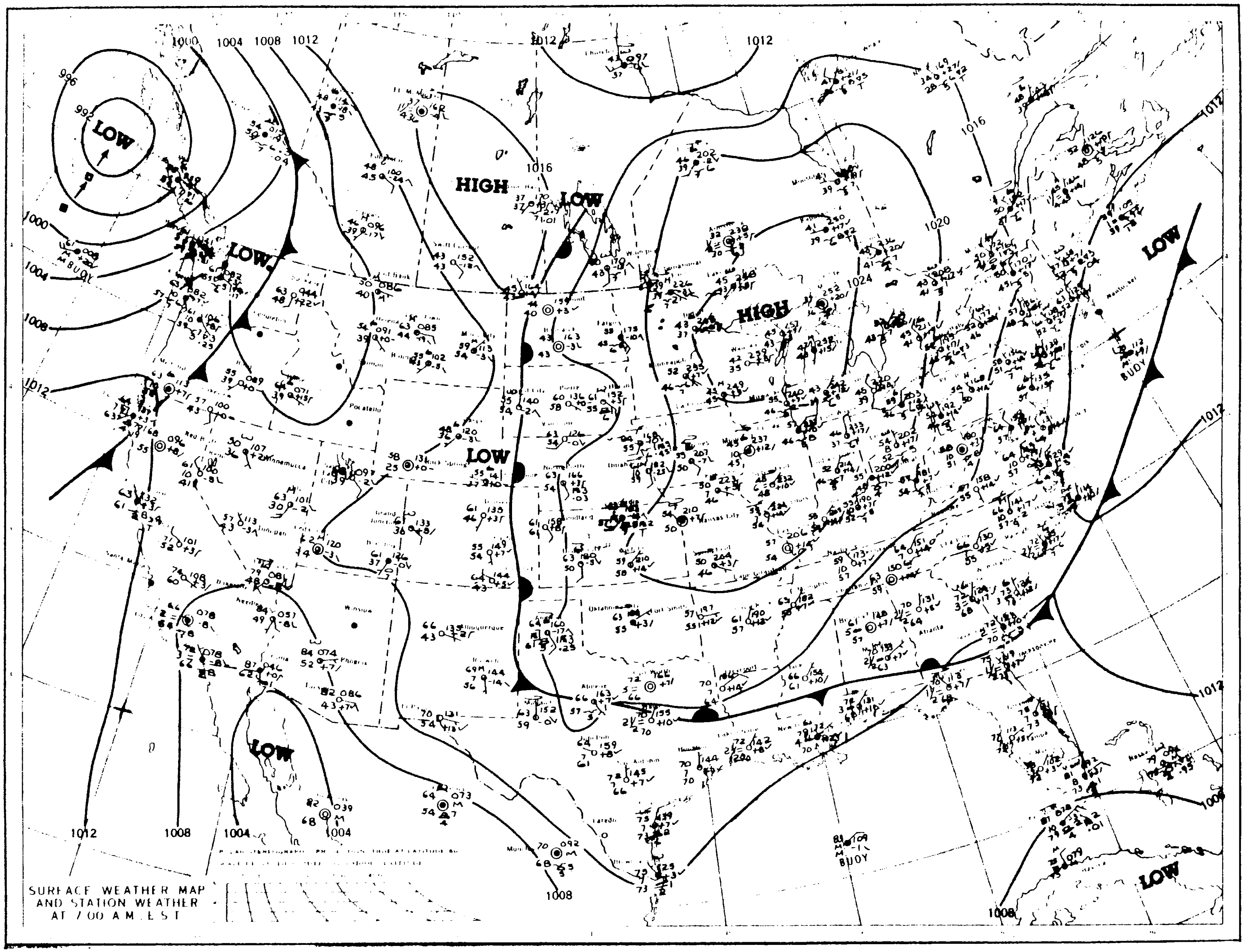


Figure 3.2.1 .Surface Weather Chart - 8 September 1979 (05 PDT)

Table 3.2.1

SURFACE WINDS AT OILDALE (SAN JOAQUIN TOWER)
8 SEPTEMBER 1979

Time (PDT)	Wind Direction/Speed (m/s)
02	190/0.4
03	210/1.3
04	180/1.8
05	165/1.3
06	195/1.8
07	180/1.8
08	200/1.8
09	230/1.3
10	210/1.2
11	200/2.2
12	275/4.9

Transport on a regional basis can also be described from the streamlines constructed from the 1000 ft-agl winds. The flow depicted in Figure 3.2.3 characterizes conditions during the early portion of the tracer release period when the flow was typically northwest throughout the valley. By 0500 PDT the flow in the southern extreme of the valley was altered by the development of an eddy induced by the terrain and stabilization of the atmosphere. The streamline pattern resulting from these conditions is shown in Figure 3.2.4 for 0900 PDT when the eddy had fully developed. The typical afternoon streamline pattern is depicted in Figure 3.2.5. Flows during the afternoon of the 8th were similar to those during Test 1, although wind speeds were generally higher in the north and central valley. Speeds ranged from 7-10 m/s at Stockton, 5-15 m/s at Fresno, and 2-5 m/s at Bakersfield. The flow remained generally from the northwest throughout the night until development of the eddy again in the early morning at the southern extreme of the valley.

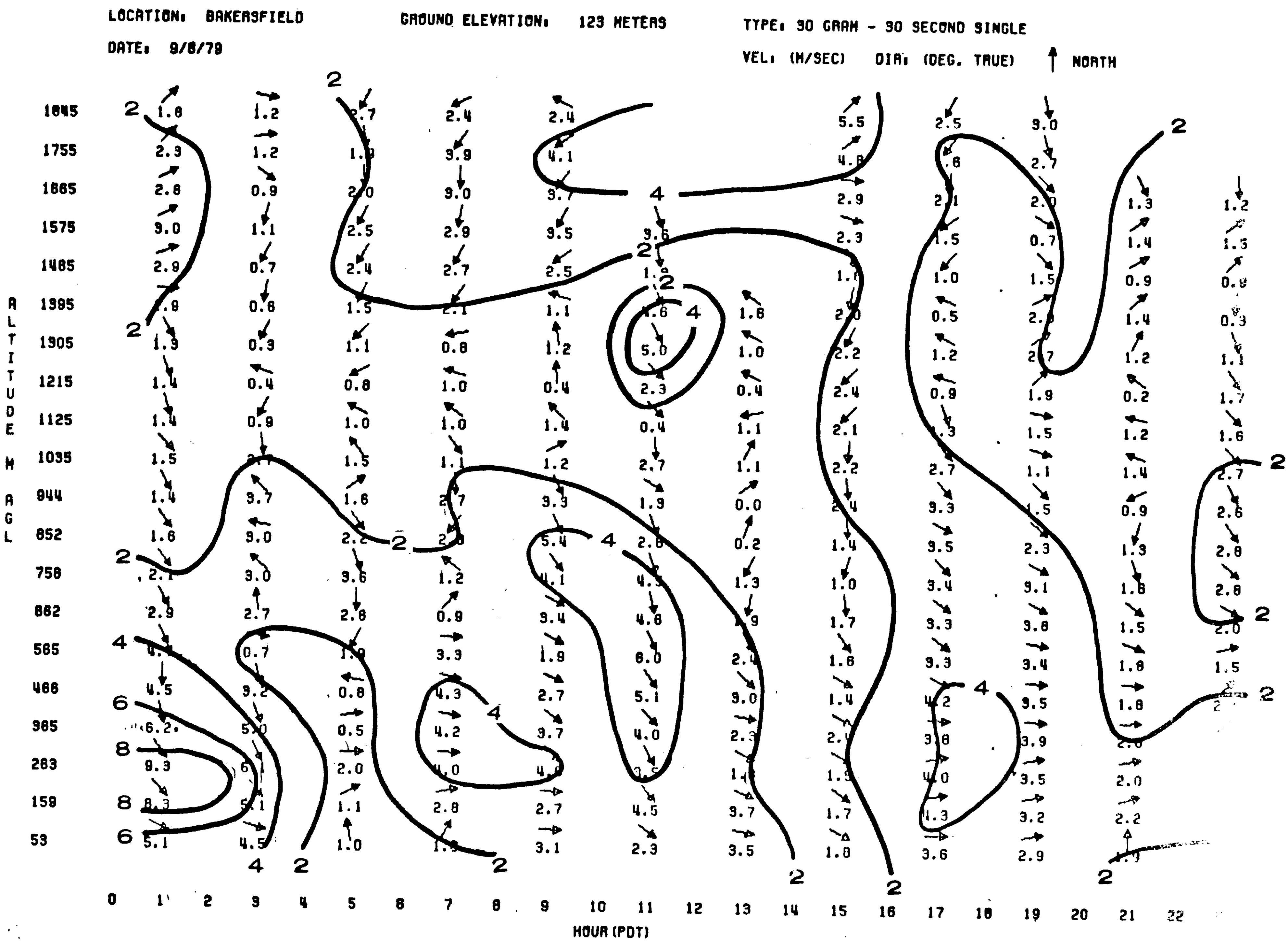


Figure 3.2.2 Time-Height Cross Section From Madera - 8 September 1979

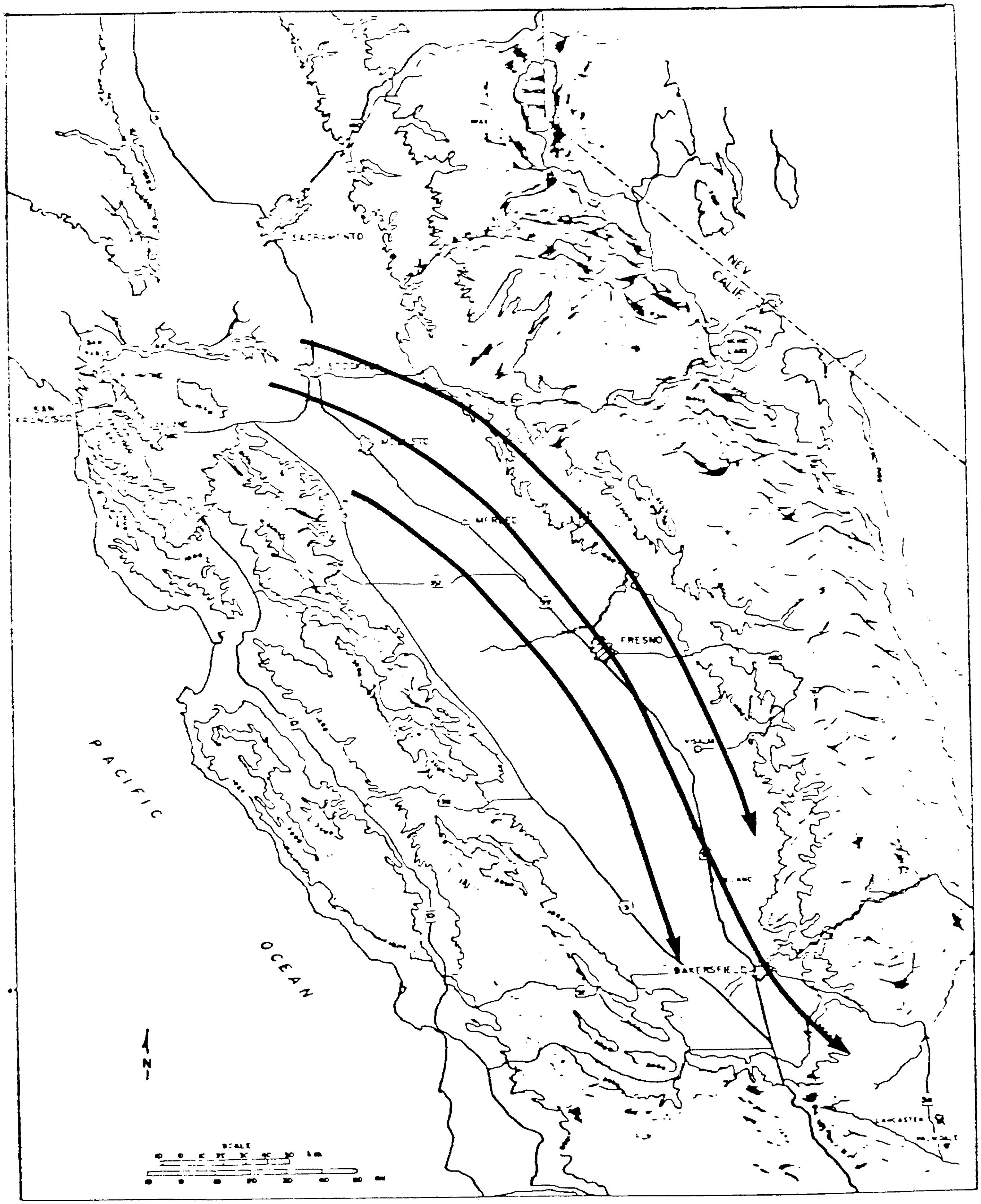


Figure 3.2.3 1000 Ft-agl Streamlines - 8 September 1979 (03 PDT)

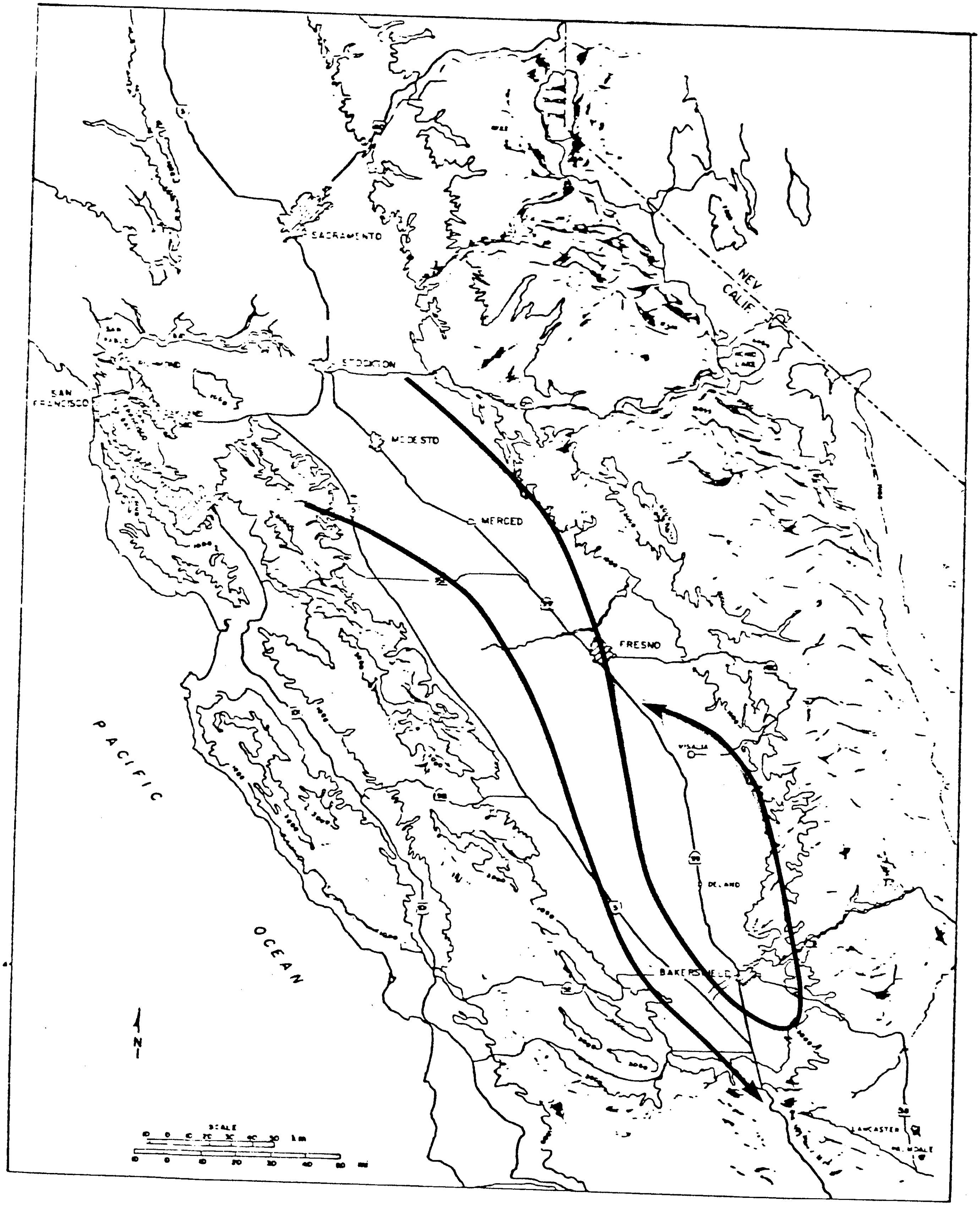


Figure 3.2.4 1000 Ft-agl Streamlines - 8 September 1979 (09 PDT)

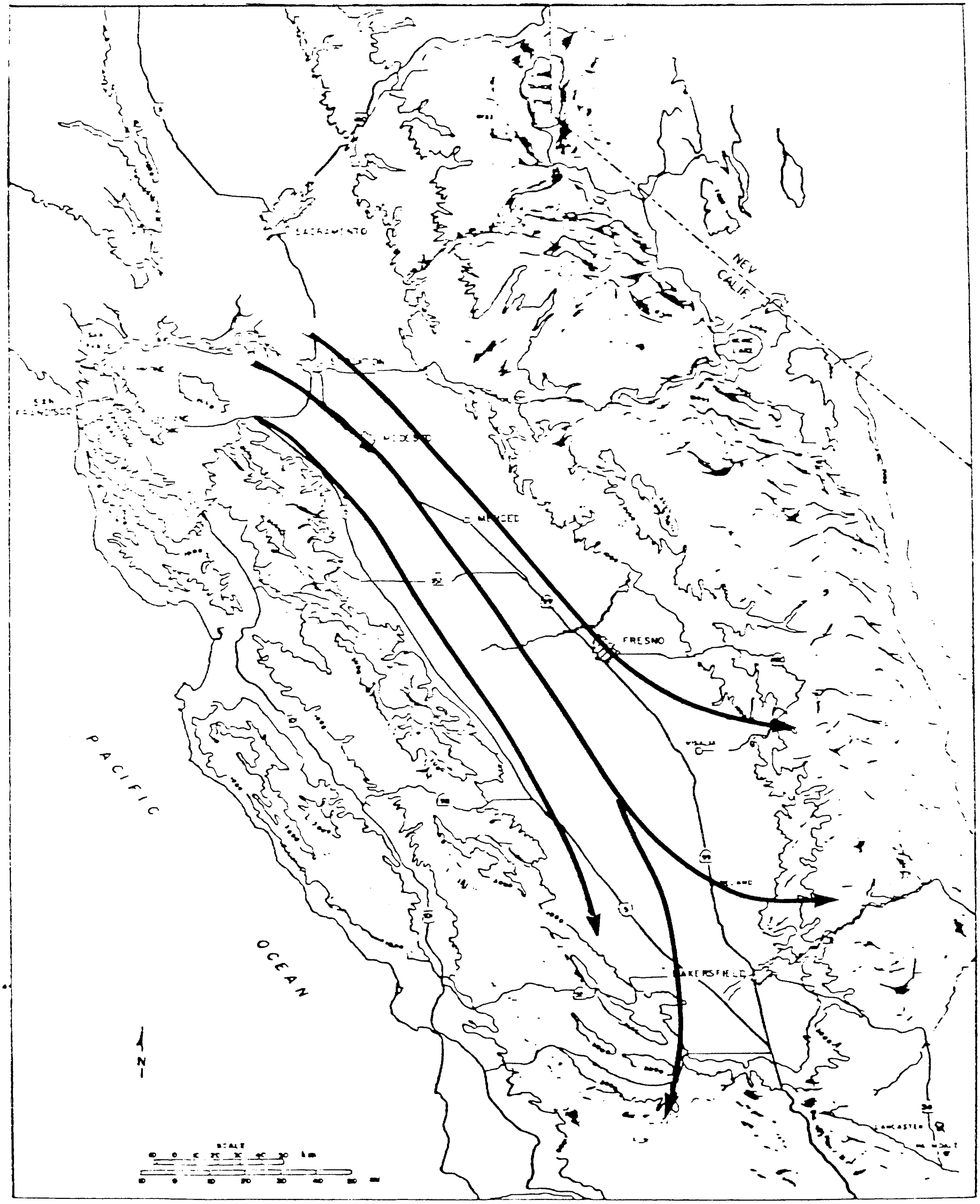


Figure 3.2.5 1000 Ft-agl Streamlines - 8 September 1979 (17 PDT)

Mixing Heights

Mixing heights measured by the aircraft on September 8-9 are given in Table 3.2.2. Heights ranged around 600 to 800 m during the late afternoon of September 8. On the following morning, low level stability was not as pronounced as observed in Test 1 and morning mixing heights were somewhat higher.

Table 3.2.2

AIRCRAFT MIXING HEIGHTS

Time (PDT)	Location *	Mixing Height (m [above ground level])
	September 8, 1979	
1438	4 NW Bakersfield	650
1636	Caliente	670
1753	4 NW Bakersfield	870
	September 9, 1979	
0704	4 NW Bakersfield	150
0826	Caliente	650
0929	27 SSE Bakersfield	570
1005	Taft	810
1044	Wasco	500

(* Distances in miles)

3.2.2 Air Quality

Regional Pollutant Levels

Maximum hourly average ozone concentrations for 8 September are shown on Figure 3.2.6. Ozone concentrations were generally low over the entire region. However, exceedances of California's ambient air quality standard were experienced at Shaver Lake and Whitaker Forest, both in the Sierra Nevadas east of Fresno, and at Fountain Springs in the Sierra foothills.

Maximum hourly concentrations of SO_2, CO and NO_x anywhere in the valley on September 8 are shown in Table 3.2.3. Maximum hourly values recorded at the Rockwell International vans are also given. Observed concentrations were generally low throughout the valley and were similar to or slightly less than measured on September 5.

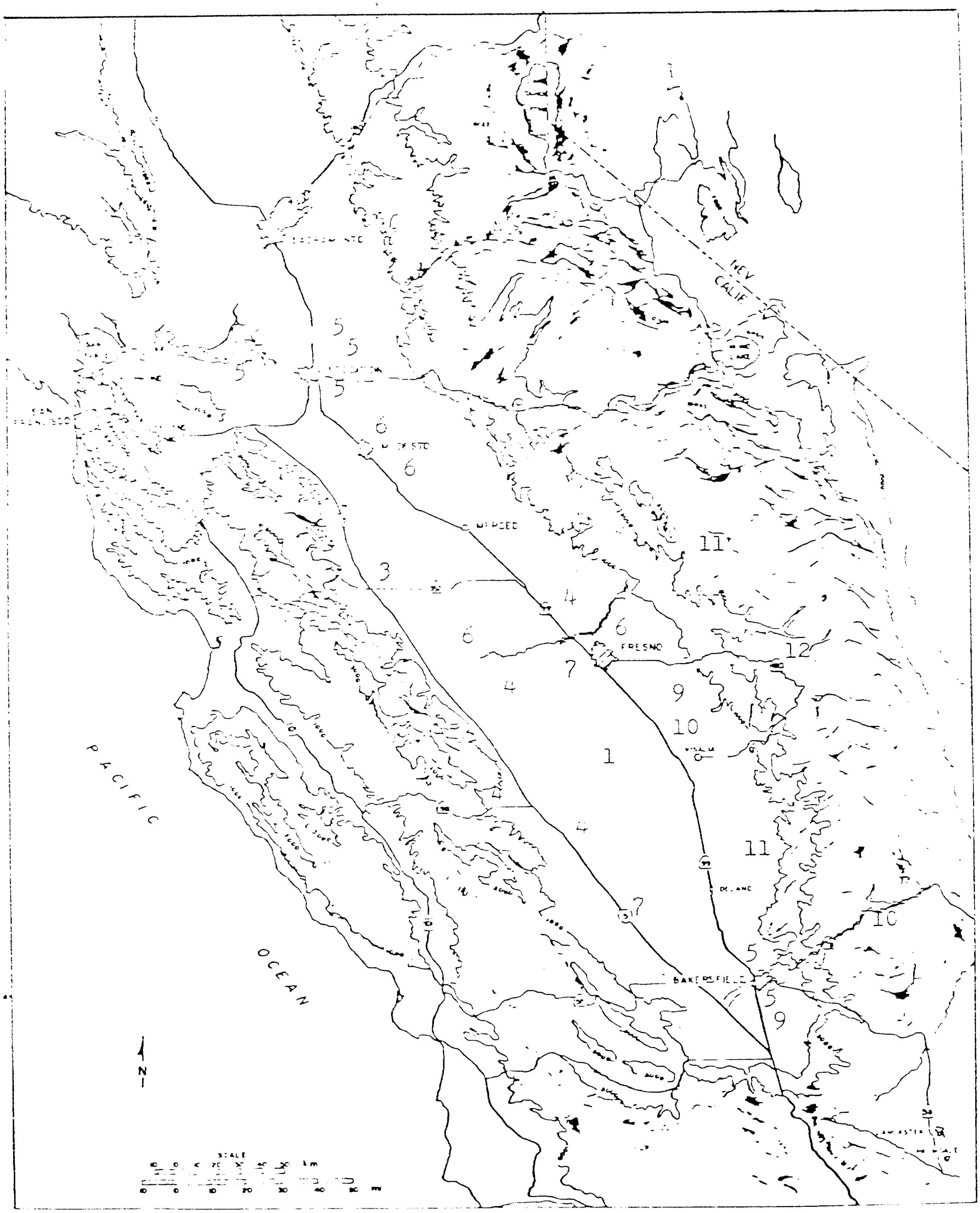


Figure 3.2.6 Maximum Hourly Ozone Concentrations (pphm) - 8 September 1979

Table 3.2.3

MAXIMUM HOURLY CONCENTRATIONS
SEPTEMBER 8, 1979

Parameter	Location	Maximum Value (ppm)
SO_2	Bakersfield	.01
SO_2	Visalia	.01
CO	Bakersfield	3
NO_x	Bakersfield	.17
SO_2	Arvin (RI)	< .01
SO_2	Lost Hills (RI)	.01
SO_2	Reedley (RI)	< .01
NO_x	Arvin (RI)	.01
NO_x	Lost Hills (RI)	.04
NO_x	Reedley (RI)	.02

Aircraft Sampling

In conjunction with an early morning tracer release from Oildale on the 8th, two sampling flights were made. The first flight in the afternoon of the release day (1436-1810 PDT), sampled the southern region of the San Joaquin Valley and into the Sierra foothills toward Techachapi Pass. Horizontal traverses were flown within the surface mixing layer and vertical sampling was performed over Bakersfield, Caliente, and Tehachapi. Sampling again took place the following morning. This flight included horizontal sampling traverses at 1370 m-msl throughout the southern San Joaquin Valley and into the mountains towards Tehachapi, the southern extreme of the valley, Taft, and Wasco.

In the afternoon sampling, the spirals over the Bakersfield VOR and over Caliente showed similar characteristics. Vertical mixing took place from the surface to near 4600 ft-msl. Ozone levels increased with altitude within the mixing layer peaking in the 1000 foot thick layer below the top of mixing. Maximum ozone levels observed were .14-.15 ppm over the Bakersfield area, near .16 ppm over Caliente, and .11 ppm over Tehachapi. Ozone levels over Bakersfield increased about .01 ppm on the average during the sampling period.

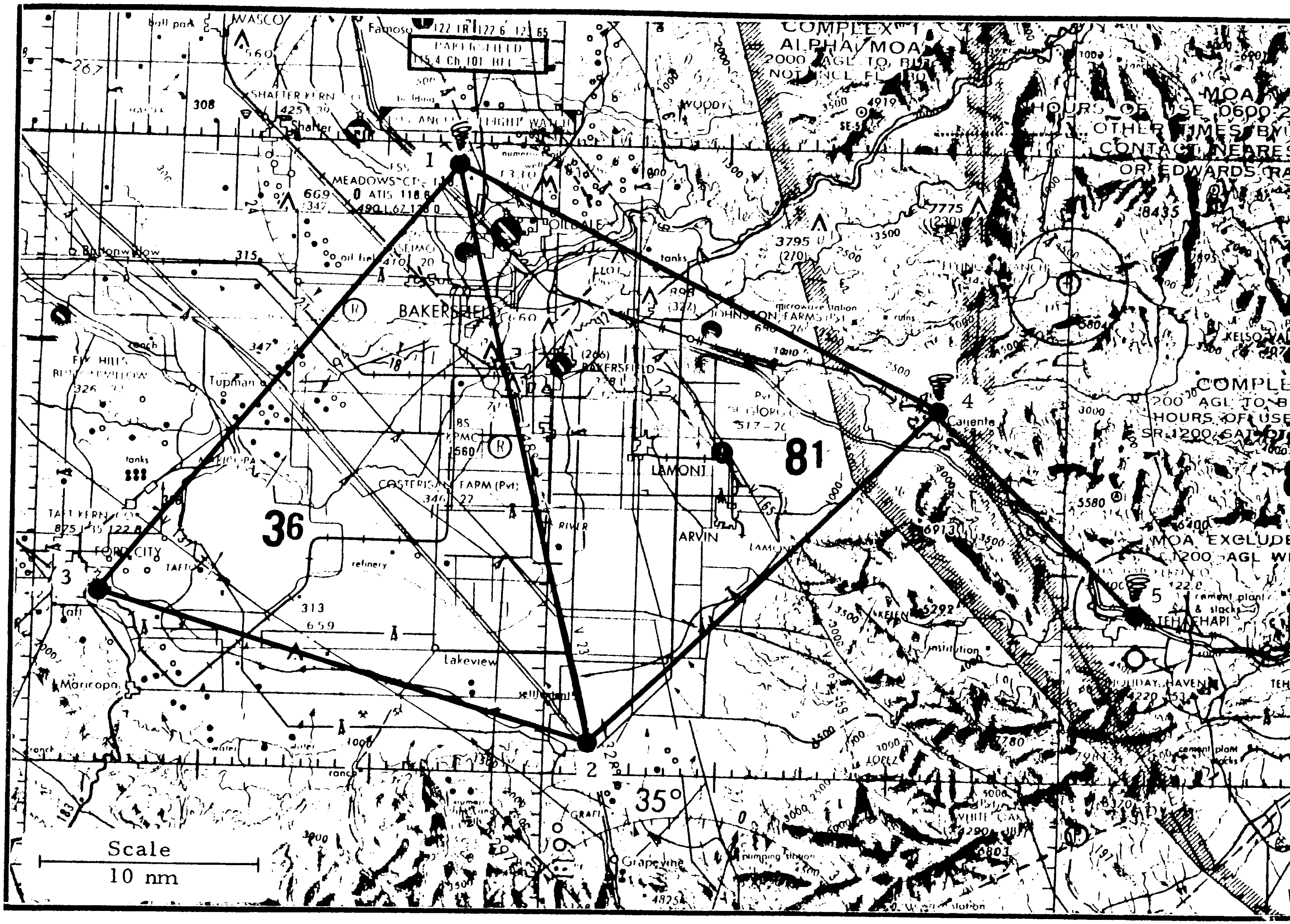
The horizontal distribution of ozone and b_{scat} showed peak levels of approximately .16 ppm to the southeast of Bakersfield with the greatest concentrations beginning in the foothills northwest of Caliente and extending to almost Tehachapi. Gradients decreased in a somewhat linear manner towards the center of the valley. Ozone levels were in the .07-.09 ppm range outside the urban influence in the central and west portions of the valley. Background levels of SO_2 and oxides of nitrogen were low during this sampling period.

On the following morning, the series of spirals which were flown in the southern San Joaquin Valley and in the Tehachapi Pass regions were characterized by a strong temperature inversion (6-8°C) based at an average height of 4600 ft-msl with an ozone-rich layer at or near the inversion base. Maximum ozone concentrations in that layer ranged between .09-.11 ppm in the mountain passes and valley with the exception of the most northerly sampling location near Wasco where levels near .15 ppm were encountered. The horizontal distribution of pollutants at this altitude was relatively constant except on the traverse from Taft to Wasco where ozone concentrations increased to the aforementioned levels. A pooling of pollutants from local sources is also evident within the surface-based nocturnal inversion on the Bakersfield spiral (1439 PDT).

Figure 3.2.7 shows the sampling pattern followed during the afternoon flight on September 8. Summarized pollutant characteristics found during the flight are given in Table 3.2.4. Aircraft soundings made during the flight are shown in Figures 3.2.8 to 3.2.10.

Figure 3.2.8 shows a sounding made near Bakersfield at 1438 PDT. The mixed layer extended to 800 m (msl) and included ozone levels of about .10 ppm. An elevated ozone layer (.14 ppm) was centered between 1100 and 1400 m (msl). An inversion capped this layer with dry and relatively clean air.

Figure 3.2.9 was made at Caliente at 1636 PDT. As indicated on September 5, ozone levels at Caliente were higher than observed at Bakersfield. Highest values (.15 ppm) were again at about 1400 m (msl) in a layer above the mixed layer. The layer of dry, clean air above 1600 m (msl) was also present at Caliente.



SAMPLING ROUTES 8 SEPTEMBER 1979

Figure 3.2.7

Table 3.2.4

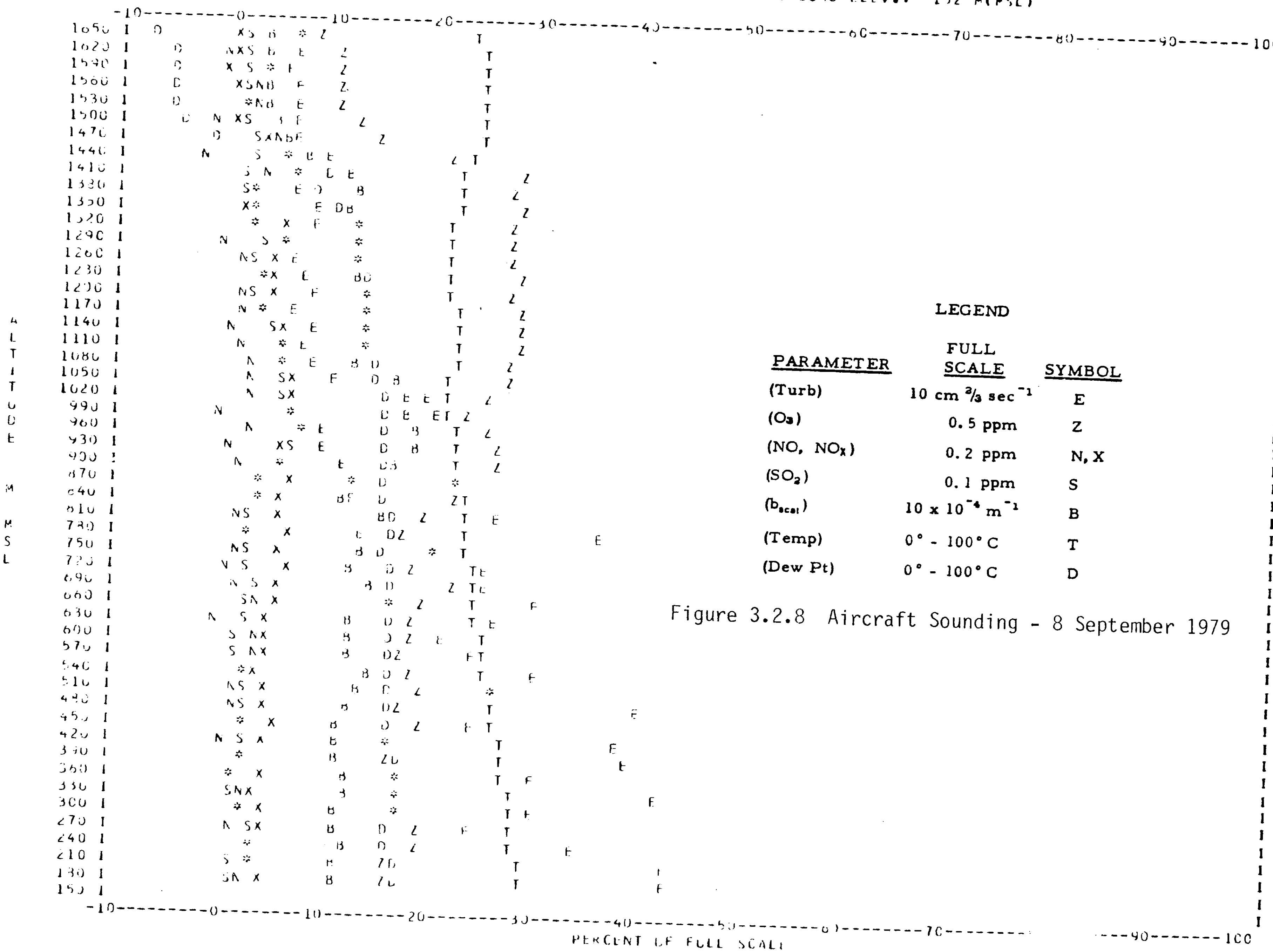
AIR QUALITY MEASUREMENTS CARB SAN JOAQUIN VALLEY PROJECT
SEPTEMBER 8, 1979 SAMPLING

Start Time (PDT)	Location (Point)	O_3 Mean (ppb)	O_3 Max (ppb)	b_{scat} Mean ($x10^{-6}m^{-1}$)	b_{scat} Max ($x10^{-6}m^{-1}$)	SO_2 Mean (ppb)	SO_2 Max (ppb)	NO_x Mean (ppb)	NO_x Max (ppb)	NO Mean (ppb)	NO Max (ppb)
1439	1	91	143	98	244	2	8	6	19	1	22
1529	1-2	90	126	88	192	3	15	8	33	3	16
1546	2-3	78	89	56	116	1	2	5	15	2	9
1603	3-1	72	115	64	140	1	9	5	20	2	9
1621	1-4	117	160	129	220	5	9	12	24	2	8
1637	4	106	158	88	190	2	5	7	16	2	8
1654	5	80	118	54	118	1	2	3	14	2	12
1706	5-4	131	162	102	182	3	4	9	18	3	10
1718	4-2	103	152	75	160	2	4	6	19	3	20
1734	2-1	94	136	83	152	3	22	8	43	3	12
1754	1	98	150	83	220	1	2	4	13	1	9

COMPLT 01 ROL 03 19-APR-80 04:26:24 PAGE 3

DATE: 9/ 8/79
CARTRIDGE/PASS: 7C47 1
TIME: 14:38:44 TO 14:53:12

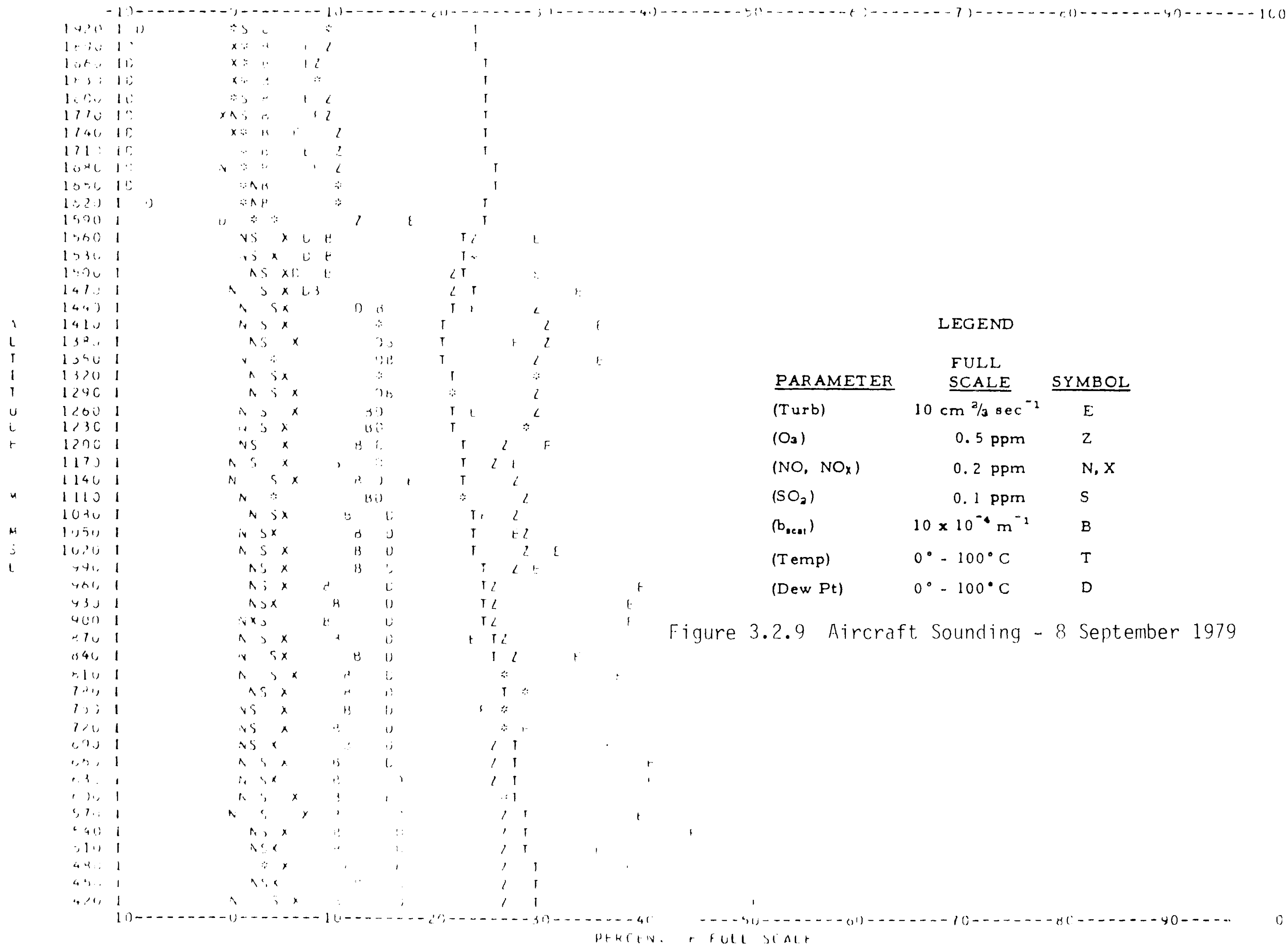
ROUTE: OVER POINT 1
MIN. GROUND ELEV.: 152 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec^{-1}	E
(O_3)	0.5 ppm	Z
(NO, NO_X)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.8 Aircraft Sounding - 8 September 1979



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3} sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_X)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.9 Aircraft Sounding - 8 September 1979

Figure 3.2.10 was made at Bakersfield at 1753 PDT, about 2-1/2 hours after Figure 3.2.8 Features of the two soundings are quite similar. The mixing layers were comparable, an elevated layer of ozone was present above the mixed layer and a dry layer capped this ozone-rich layer.

Figure 3.2.11 shows the aircraft sampling routes carried out during the morning flight of September 9. Table 3.2.5 summarizes the characteristics measured during the flight. Figures 3.2.12 to 3.2.16 show the soundings made at various locations during the flight.

Figure 3.2.12 was made at 0749 PDT near Bakersfield. A shallow layer (to 300 m above sea level) was topped by a strong elevated plume with large values of SO_2 and NO_x. Ozone concentrations were low in the surface layers but increased aloft, reaching a peak of .11 ppm at 1440 m (msl).

Figure 3.2.13 was observed at Caliente at 0826 PDT. Ozone concentrations to 1000 m (msl) were relatively low but increased aloft. A marked temperature inversion started at 1320 m (msl), characterized by relatively clean air.

The sounding at 0928 PDT (Figure 3.2.14) was made at the intersection of I-5 and Highway 99. A mixing layer extended to 570 m (above ground level). Ozone concentrations were lower at all levels than at Caliente but showed an ozone-rich layer aloft.

A sounding was made at Taft at 1005 PDT (Figure 3.2.15). The mixed layer extended to 810 m (above ground level). Ozone concentrations were relatively low but an elevated ozone layer (.11 ppm) was centered at 1410 m (msl).

Figure 3.2.16 was made at Wasco at 1055 PDT. Ozone concentrations were similar to those observed at Taft. An ozone-rich layer started at 1080 m (msl) and extended to 1500 m (msl). Peak concentration was .15 ppm at 1410 m (msl). This layer was observed in all soundings made during the morning of the 9th and clearly indicates a uniform layer over the entire southern part of the valley.

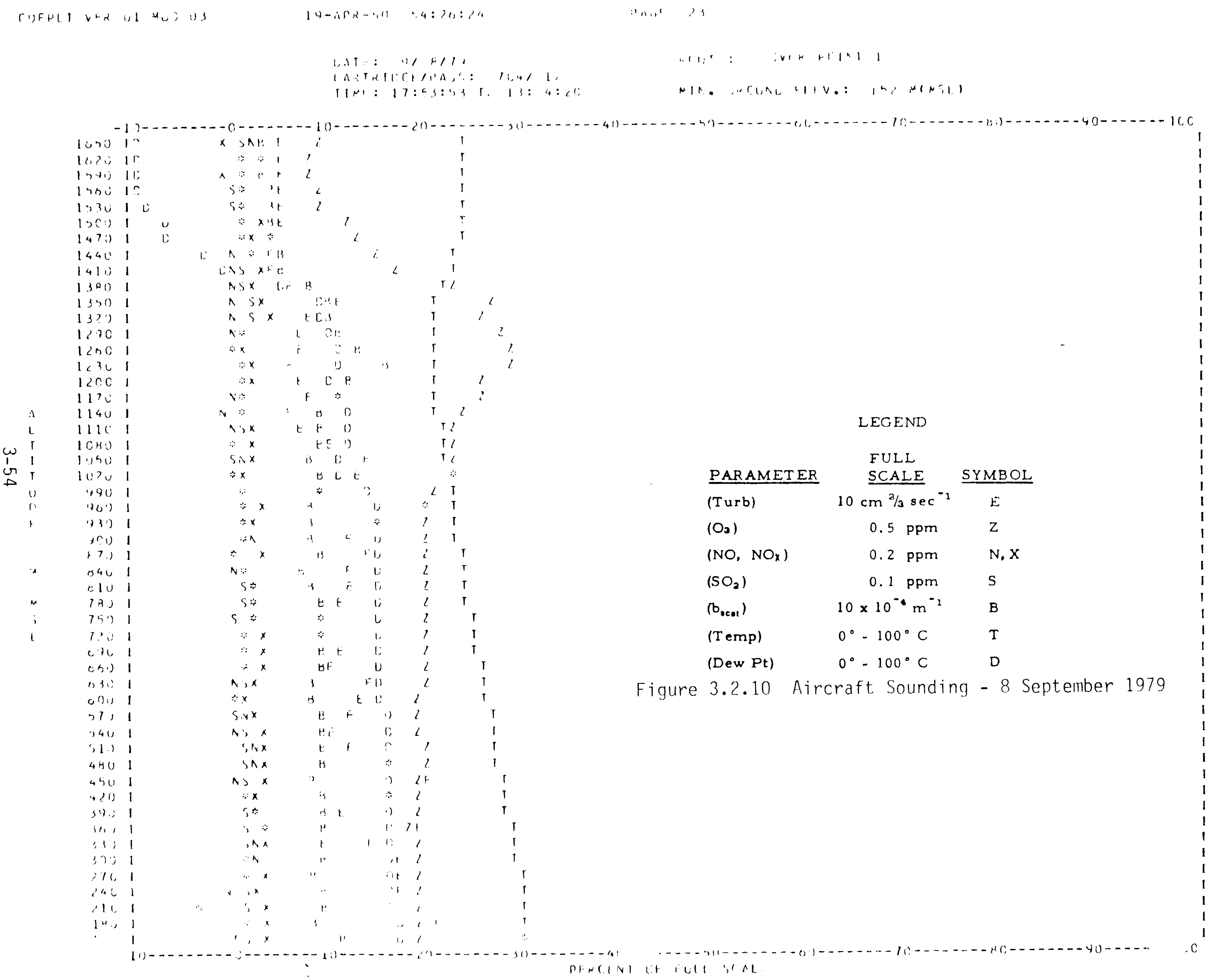
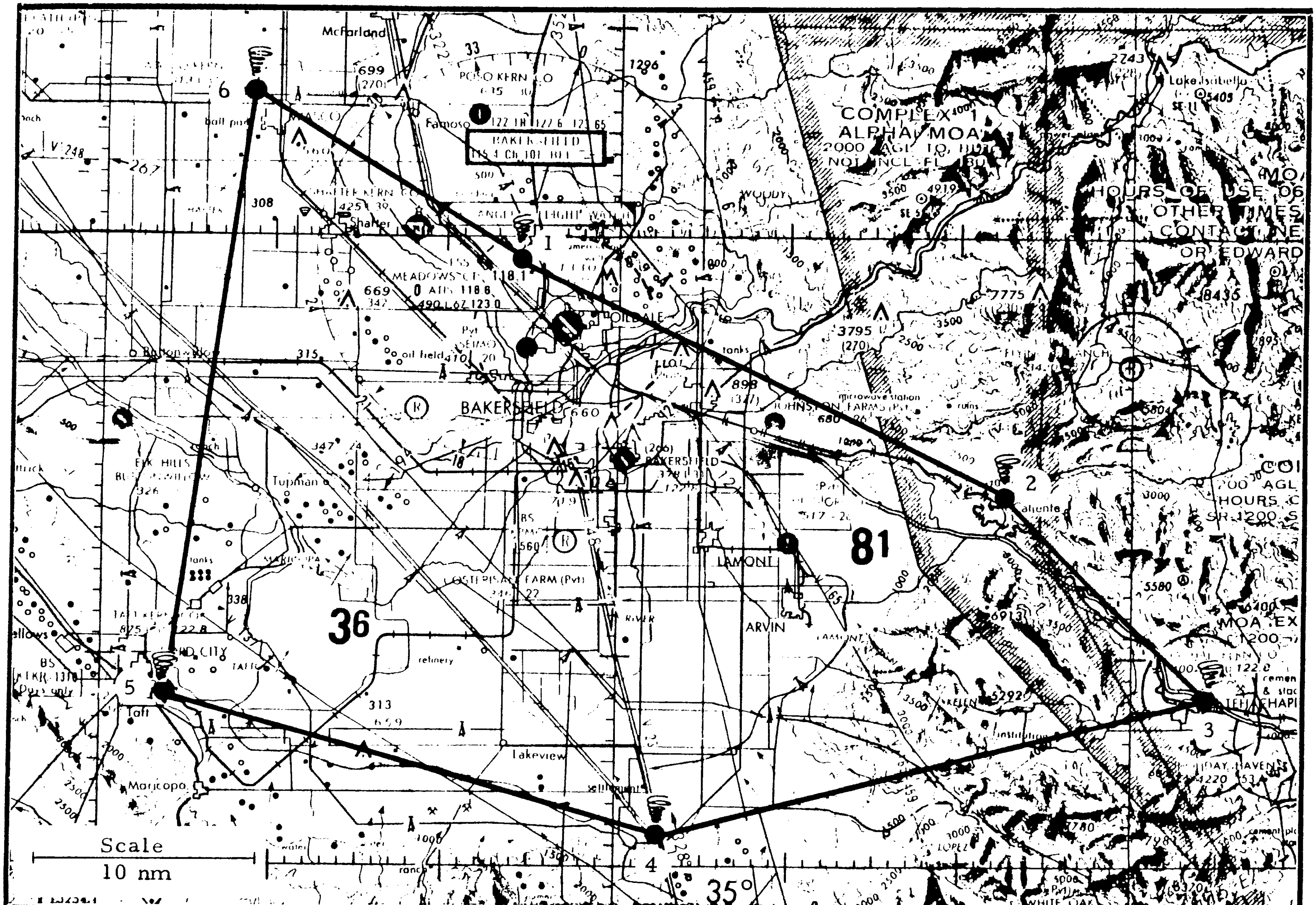


Figure 3.2.10 Aircraft Sounding - 8 September 1979



SAMPLING ROUTES 9 SEPTEMBER 1979

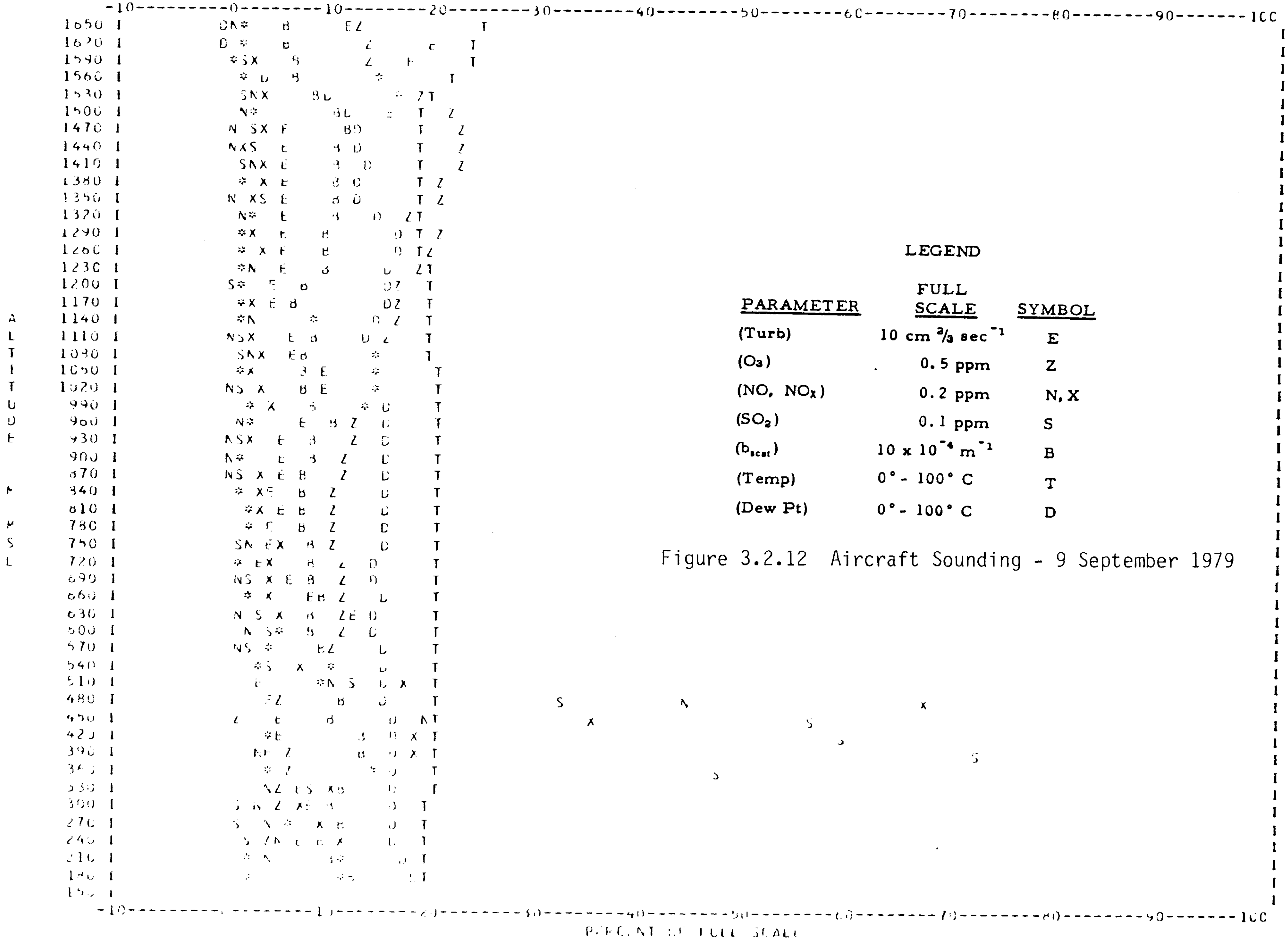
Figure 3.2.11

Table 3.2.5

AIR QUALITY MEASUREMENTS CARB SAN JOAQUIN VALLEY PROJECT
SEPTEMBER 9, 1979 SAMPLING

Start Time (PDT)	Location (Point)	O_3 Mean (ppb)	O_3 Max (ppb)	b_{scat} Mean ($x10^{-6}m^{-1}$)	b_{scat} Max ($x10^{-6}m^{-1}$)	SO_2 Mean (ppb)	SO_2 Max (ppb)	NO_x Mean (ppb)	NO_x Max (ppb)	NO Mean (ppb)	NO Max (ppb)
0750	1	64	116	83	176	7	78	12	191	6	141
0807	1-2	103	119	105	212	2	6	5	10	2	8
0826	2	68	96	91	172	3	8	9	61	3	27
0845	2-3	100	110	101	184	2	3	5	11	2	8
0853	3	75	99	68	154	2	4	5	47	2	16
0910	3-4	88	101	96	184	3	5	10	45	3	15
0928	4	72	111	76	164	2	3	9	28	3	13
0946	4-5	82	94	70	128	1	1	5	10	2	8
1006	5	67	116	60	140	1	2	7	24	2	9
1020	5-6	117	147	99	182	2	7	4	15	1	6
1045	6	76	149	68	176	1	2	3	10	3	16

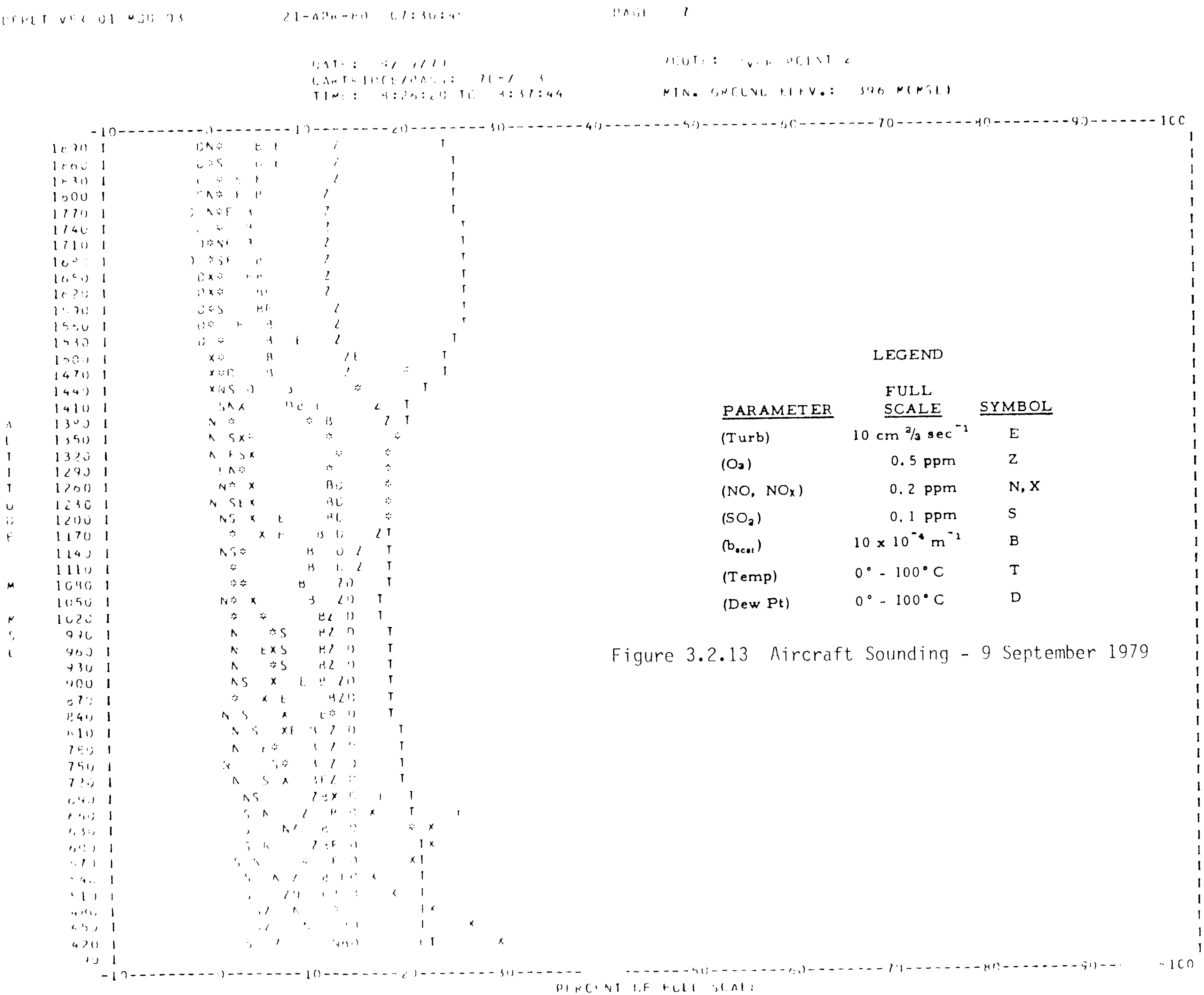
DATE: 9/ 9/79   ROUTE: OVER POINT 1
CARTRIDGE/PASS: 705/ 1
TIME: 7:49:40 TO 8: 0:51   MIN. GROUND ELEV.: 152 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2}/_{3}$ sec^{-1}	E
(O_3)	0.5 ppm	Z
(NO, NO_X)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.12 Aircraft Sounding - 9 September 1979



LEGEND

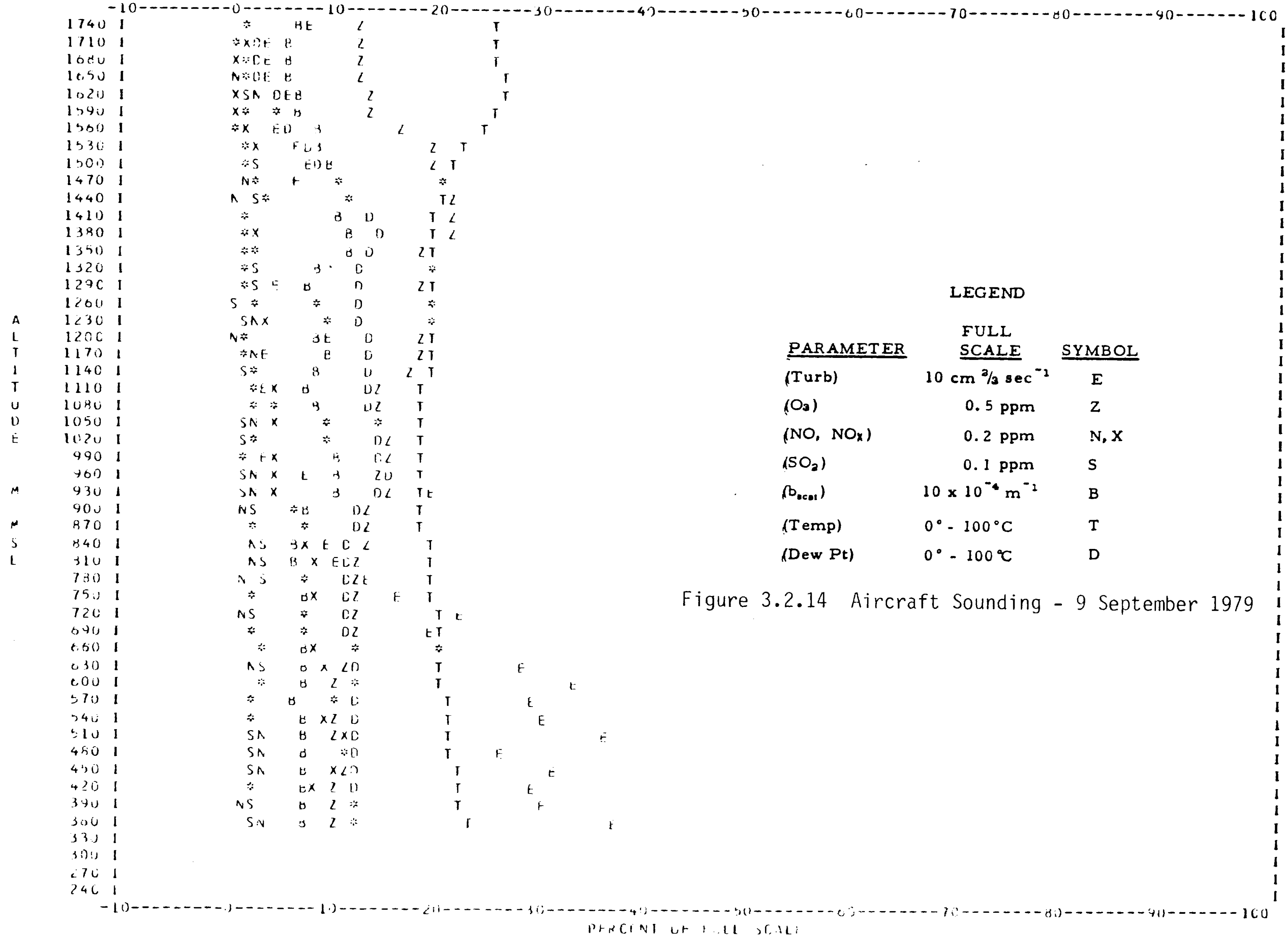
PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3} sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x $10^{-4} m^{-1}$	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.13 Aircraft Sounding - 9 September 1979

CDFPLT V.. 01 MOD 03   21-APR-80 07:30:45   PAGE 13

DATE: 9/ 9/79
CARTRIDGE/PASS: 705/ 7
TIME: 9:28:10 TO 9:39:11

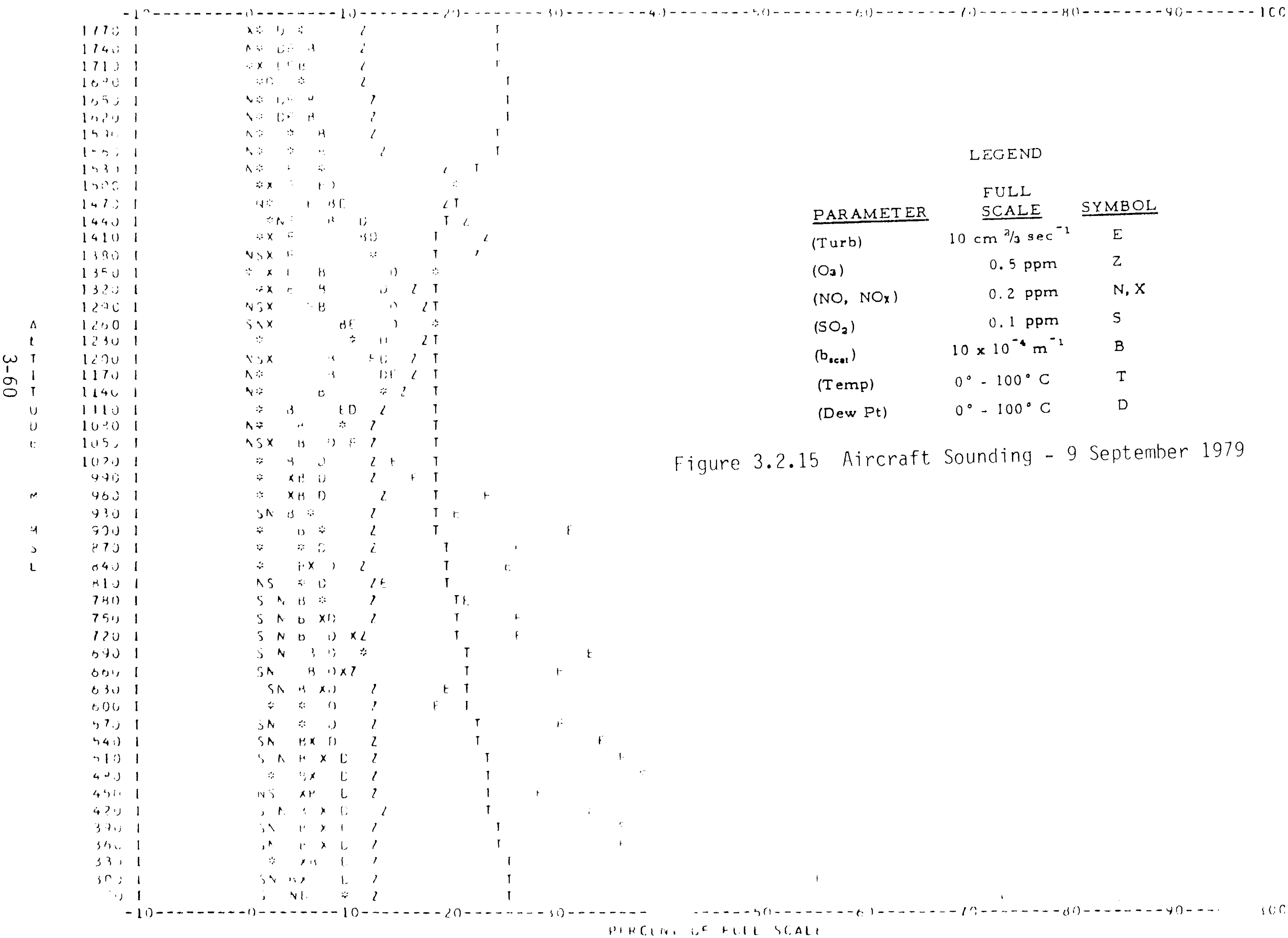
ROUTE: OVER POINT 4
MIN. GROUND ELEV.: 243 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3} sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	$10 \times 10^{-4} m^{-1}$	B
(Temp)	0° - 100°C	T
(Dew Pt)	0° - 100°C	D

Figure 3.2.14 Aircraft Sounding - 9 September 1979



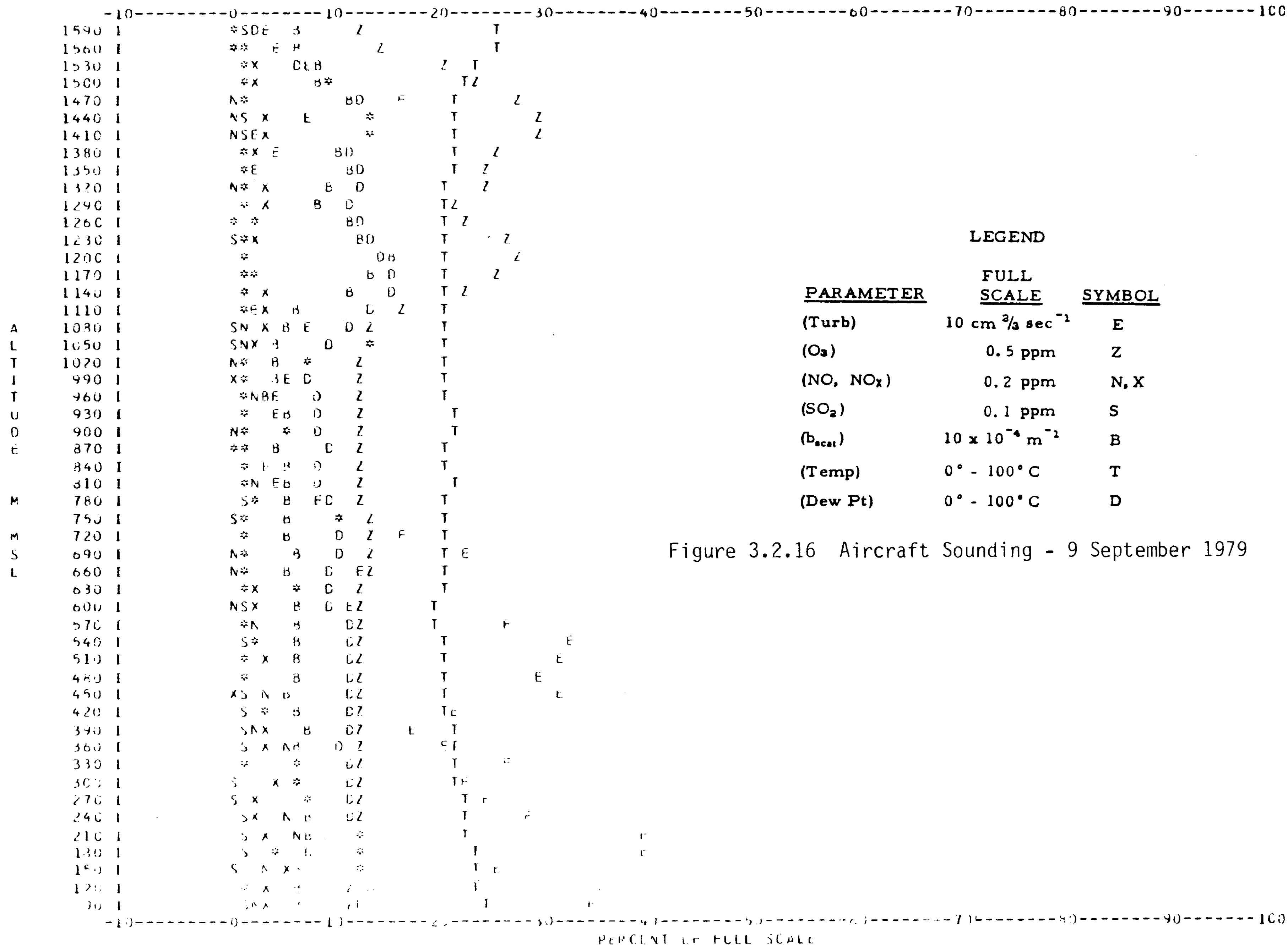
LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 cm $^{2/3}$ sec $^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.15 Aircraft Sounding - 9 September 1979

DATE: 9/ 9/79
CARTRIDGE/PASS: 705/ 11
TIME: 10:44:35 TO 10:55:46

ROUTE: [illegible]
MIN. GROUND ELEV.: 95 M(MSL)



LEGEND

PARAMETER	FULL SCALE	SYMBOL
(Turb)	10 $cm^{2/3} sec^{-1}$	E
(O_3)	0.5 ppm	Z
(NO, NO_x)	0.2 ppm	N, X
(SO_2)	0.1 ppm	S
(b_{scat})	10 x 10^{-4} m^{-1}	B
(Temp)	0° - 100° C	T
(Dew Pt)	0° - 100° C	D

Figure 3.2.16 Aircraft Sounding - 9 September 1979

3.2.3 Tracer Test 2

Release Location: Oildale, Kern County

Time and Date: 0200-0700 PDT, 9/8/79

Release Amount: 105 lbs SF_6/hr

Release conducted during southeasterly drainage winds. Typical diurnal surface wind variations (afternoon northwesterly upslope flow, nighttime southeasterly downslope flow) encountered during entire test.

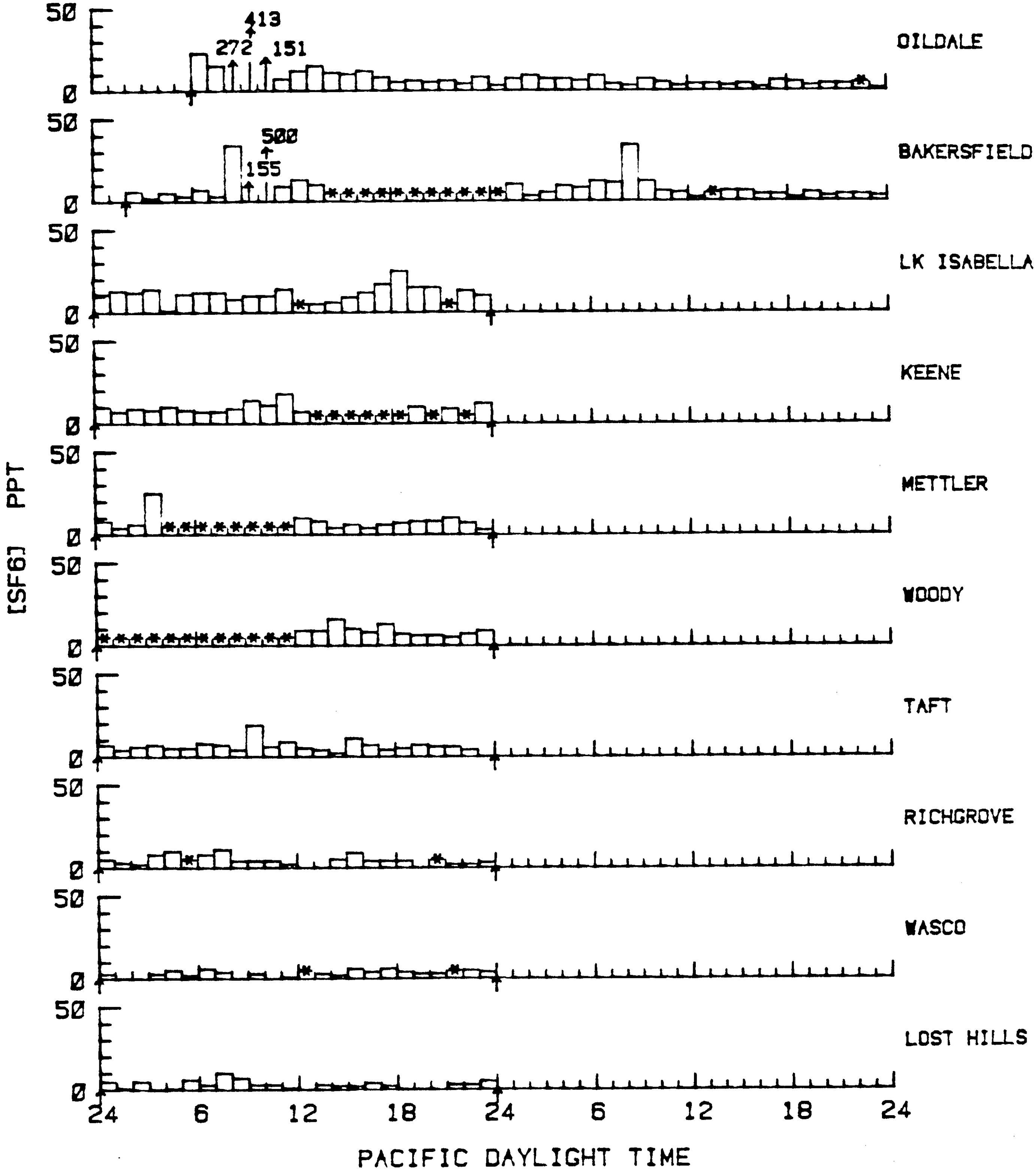
Initial Transport towards the northwest

As during the previous test, the early morning drainage winds transported the tracer northwest of the release site. Much higher concentrations were detected during automobile traverses than during the previous test, however. During Traverse 1-1, conducted between 0423 and 0508 PDT, the maximum concentration detected along Hwy 99 was slightly in excess of 4 PPB (4000 PPT). During Traverse 1-2 and 1-3, however, conducted 2 and 3 hours later, respectively, the maximum tracer concentration detected along Hwy 99 was about 13.5-15 PPB (13500-15000 PPT). This is at least 5 times higher than the concentrations detected along Hwy 99 during the first test. It was not possible to make an accurate comparison of the tracer dispersion to that predicted by the Gaussian plume model but the higher measured concentrations are consistent with the more stable atmospheric conditions that existed during the release. The tracer was transported at least as far northwest of the release site as Shafter before the typical daytime northwesterly winds reversed the transport direction of the plume. It is not known if the tracer was transported significantly further to the northwest.

Transport during upslope winds

As during the previous test, the upslope wind developed about 1100 PDT. The strength of the afternoon winds were about 3-5 mps form the northwest, again very similar to the previous test. As shown in Figure 3.2.17, the tracer was transported back through Bakersfield and Oildale. Hourly-averaged concentrations in both Oildale and Bakersfield were about a factor of 5 higher

SJV-2 9/8/79 - 9/9/79

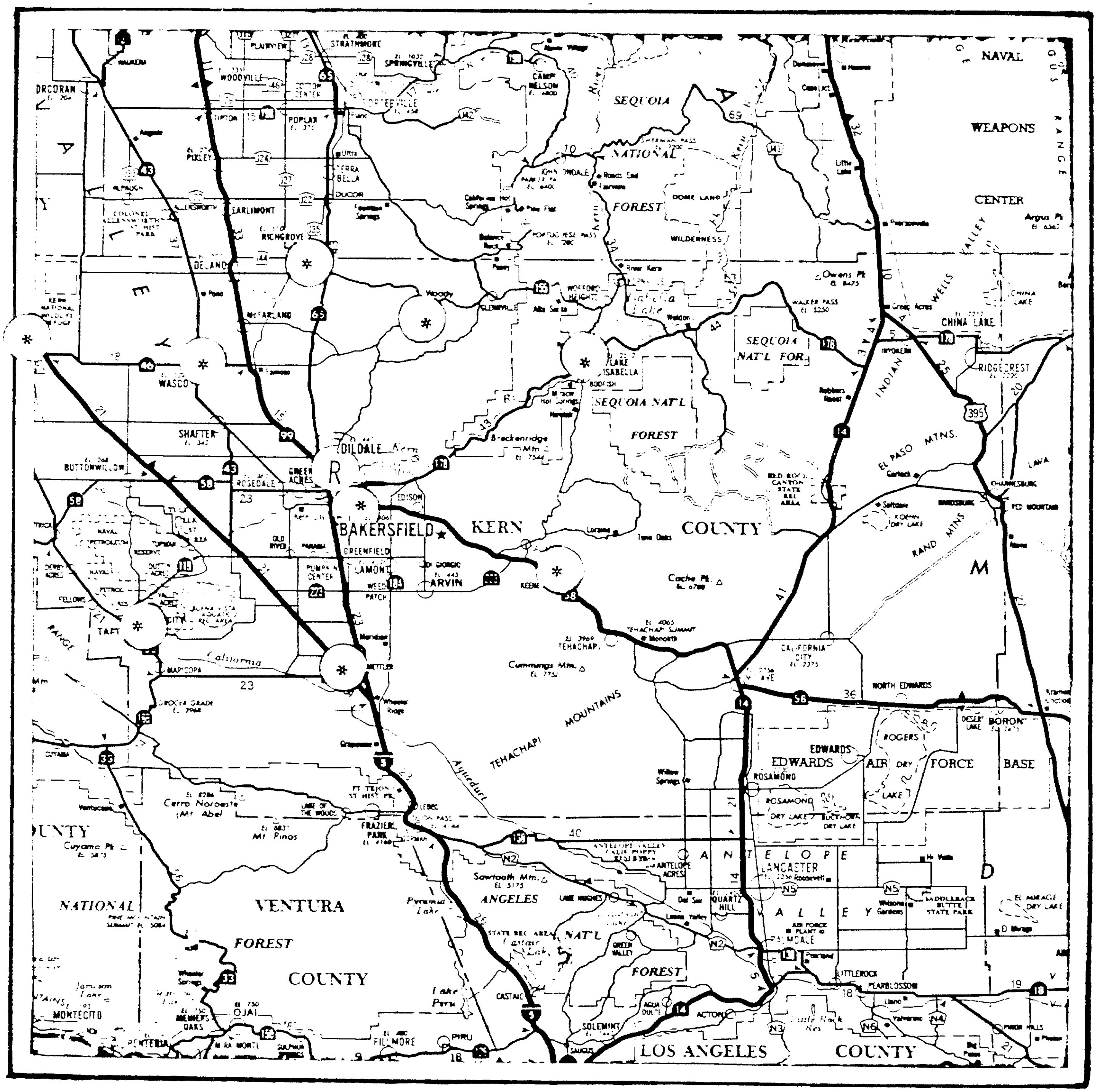


RELEASE LOCATION: 525 # SF6 AT OILDALE
RELEASE TIME: 0200-0700 PDT, 9/8/79

* INDICATES MISSING DATA
ARROWS INDICATE BOUNDS OF SAMPLING PERIOD

Figure 3.2.17

SJV
2



INDICATES SAMPLER LOCATIONS

(R) IS THE RELEASE SITE

Figure 3.2.18

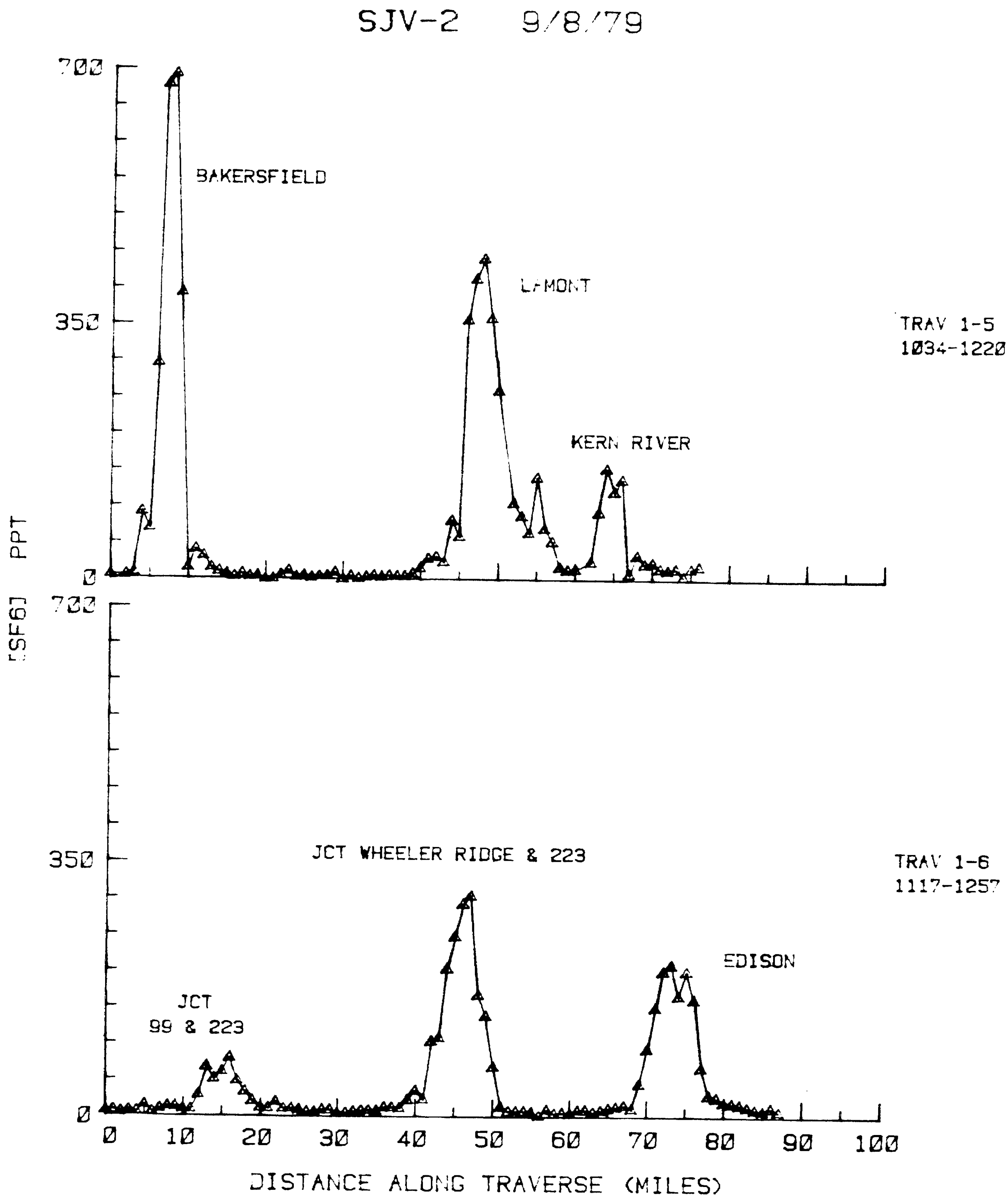
than during the previous test at about 410 and 500 PPT, respectively. As shown in Figure 3.2.19, the tracer was detected south and east of Bakersfield during Automobile Traverses 1-5 and 1-6. The highest tracer concentrations were detected southeast of Bakersfield along Hwy 223. As in the previous test, the tracer was transported into the Mojave Desert. At 2100 PDT, during Traverse 1-8, 29 PPT was detected in the town of Mojave. This compares favorably with 20 PPT detected between 2000 and 2100 PDT by a an hourly-averaged sampler at Mojave during the previous test. Evidently the earlier release time had very little effect on the measured impact of the tracer in the Mojave Desert. The only detectable differences between this and the previous test was the initialy higher concentrations due to the release under more stable atmospheric conditions and the reduced impact directly east of the release point since the release ended well before the transition to the upslope flow conditions.

Carryover of tracer

Again as in the previous test, a significant amount of tracer was apparently not transported out of the San Joaquin Valley on the day of the release. An examination of Figure 3.2.17 shows that low concentrations of the tracer were detected throughout the night following the release at Bakersfield and Oildale. A maximum of 34 PPT was detected at Bakersfield between 0800 and 0900 PDT on the morning of the day following the release. Automobile traverses on the day after the release also indicated low but non-zero tracer concentrations throughout the southern San Joaquin Valley. It was not possible to estimate the percentage of the tracer remaining within the valley.

Summary

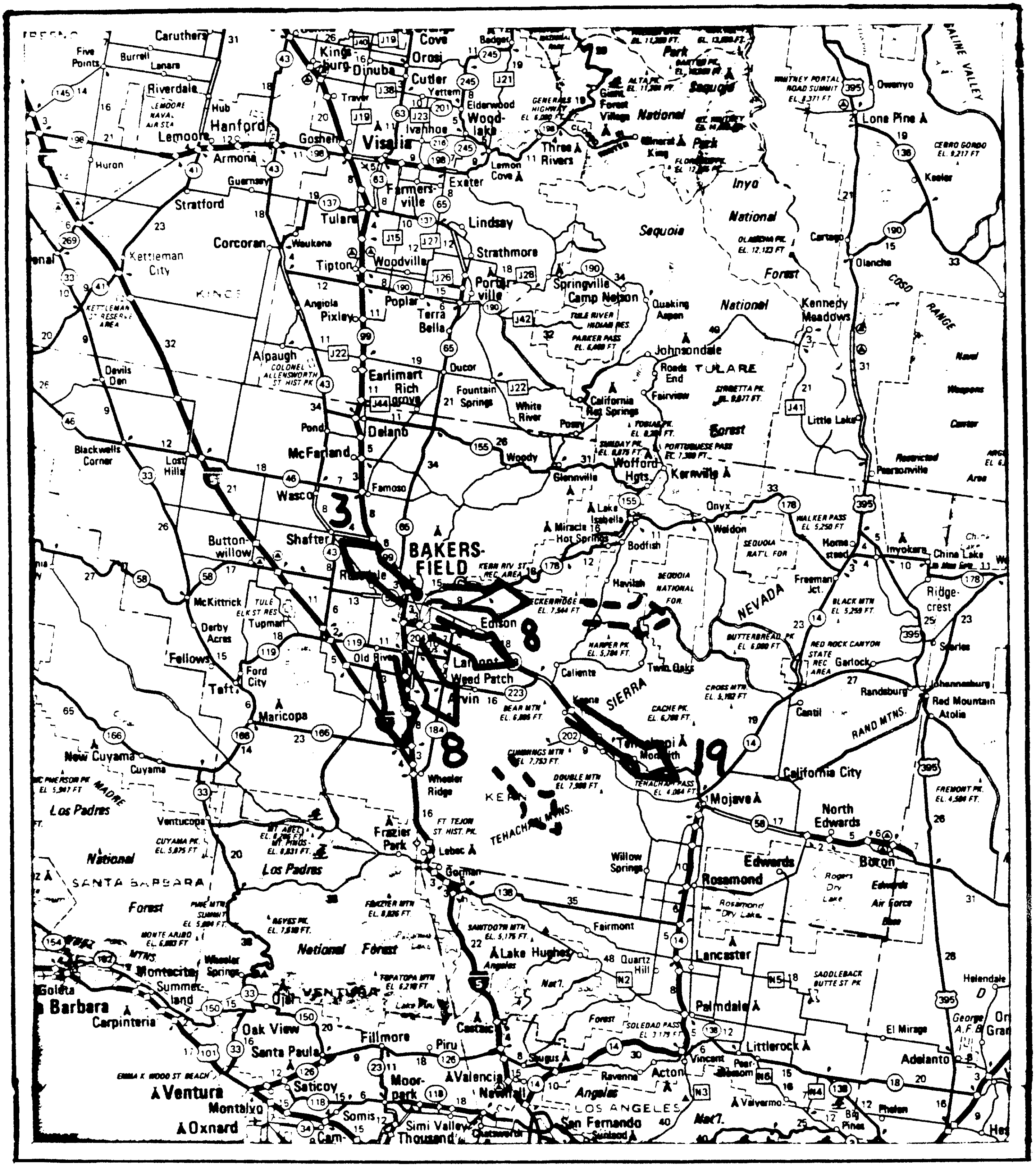
This experiment was conducted in order to determine the effect of varying the release time on the results of the previous test. As indicated in Figure 3.2.20, there was in fact no significant difference between this test and the previous one. The wind reversal near noon spread the tracer over a wide area, from where it was transported up and over the Tehachapi Mountains during the afternoon. The impact of the tracer at Mojave was very close to the impact measured during the previous test. The impact of the tracer near China Lake,



TRAVERSE SAMPLING SOUTH & EAST OF BAKERSFIELD

RELEASE LOCATION: 525 # SF6 AT OILDALE
RELEASE TIME: 0200-0700 PDT, 9/8/79

Figure 3.2.19



RELEASE SITE - FELLOWS
ARROW POINT INDICATES OBSERVED TRACER LOCATIONS
NUMBERS REFER TO HOURS AFTER RELEASE START (0200 PDT, 9/8/79)

Figure 3.2.20

while not measured, was presumably lower during this experiment since the release ended well before the upslope flow began. Thus locations east of the release site were also impacted by a diluted reversed tracer plume and not a direct plume as in the previous test.